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A case study of introducing innovation through design

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THESIS

A CASE STUDY OF INTRODUCING INNOVATION THROUGH DESIGN

by

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March 2014

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13. ABSTRACT (maximum 200 words)

In September of 2013, senior submarine officers from across the United States Navy Submarine Force converged on Naval Station Pearl Harbor to participate in a collaborative, design thinking workshop. The overarching goal of this workshop, titled the Executive Tactical Advancements for the Next Generation Forum, was to leverage the knowledge and creativity of current and post-command submarine officers to address the unique needs of the commander through the incorporation of new technologies. The result of the forum was 11 innovative solutions to improve command effectiveness.

As more of the problems of the world continue to become wicked, it is ever more important to have the ability to generate solutions using a collaborative approach to leverage the wisdom and creativity of the collective. While this technique is useful for determining unique solutions to complex problems, actually incorporating those solutions into an existing organization requires skillful execution of change management. The forum provided a unique opportunity to construct a case study demonstrating that design thinking can be used to spark innovation and change, offering Defense Department leadership an opportunity to explore alternative problem-solving methods and their application to the military environment.

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A CASE STUDY OF INTRODUCING INNOVATION THROUGH DESIGN

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ABSTRACT

In September of 2013, senior submarine officers from across the United States Navy Submarine Force converged on Naval Station Pearl Harbor to participate in a collaborative, design thinking workshop. The overarching goal of this workshop, titled the Executive Tactical Advancements for the Next Generation Forum, was to leverage the knowledge and creativity of current and post-command submarine officers to address the unique needs of the commander through the incorporation of new technologies. The result of the forum was 11 innovative solutions to improve command effectiveness.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADM	Admiral
APB	advanced processing build
APL	Applied Physics Laboratory
ARCI	acoustic rapid COTS insertion
CAPT	Captain
CDR	Commander
CEO	chief executive officer
CO	commanding officer
COB	chief of the boat
COMSUBFOR	Commander, Submarine Force
COTS	commercial off-the-shelf
DEVRON-12	Submarine Development Squadron TWELVE
DH	department head
DOD	Department of Defense
HMW	“how might we” question
IWS	Integrated Warfare Systems
JO	junior officer
LCDR	Lieutenant Commander
MAJ	Major
MCPON	Master Chief Petty Officer of the Navy
NASA	National Aeronautics and Space Administration
NR	Office of Naval Reactors
OMIWG	Operator/Machine Interface Working Group
OOD	officer of the deck
PEO	Program Executive Office
PQS	personnel qualification standards
RADM	Rear Admiral (Upper Half)
SSBN	ballistic missile submarine
SSGN	guided missile submarine
SSN	fast attack submarine

STRG	Submarine Tactical Requirements Group
TANG	Tactical Advancement for the Next Generation
TI	technology insertion
USS	United States Ship
VADM	Vice Admiral
XO	executive officer

I. INTRODUCTION

A. PURPOSE

Submarine commanding officers (COs) must execute their duties amid an endless stream of incoming information and data. This is a problem in a hierarchically structured organization because the key decision maker, the commanding officer, can quickly become overwhelmed. To address this concern, Naval Sea Systems Command (NAVSEA) and Submarine Development Squadron TWELVE (DEVRON-12) partnered with the Johns Hopkins University Applied Physics Lab (APL) and IDEO, a world-renowned design thinking firm, to guide a group of senior submariners through a collaborative design thinking and innovation workshop. The goal of this forum, appropriately named the Executive Tactical Advancements for the Next Generation (TANG), was to capitalize on the creative potential inherent in design thinking to improve the effectiveness of the commanding officer. This also provided a unique opportunity to examine how these processes play out amidst a group of experienced leaders, highly indoctrinated into the organizational culture of their war fighting community. Using established design thinking and change management theory, the researchers intend to synthesize the key elements of the Executive TANG experience, extracting those that may prove useful to future design thinking endeavors within the Department of Defense (DOD).

B. BACKGROUND

The case study has become a popular and effective tool used by most business and management schools as well as leadership courses throughout the world. According to Gary Thomas, the case study "provides the most vivid, the most inspirational analysis that an inquiry can offer."[1] Case studies are effective in teaching management and leadership principles because they immerse the reader in the particular situation, giving the student a feeling of similar experience to that in the case study. When compared to

[1] Gary Thomas, *How to Do Your Case Study: A Guide for Students and Researcher* (Los Angeles: Sage Publications, 2011), Preface X.

the traditional lecture-style instruction, conducting case studies is more effective at promoting critical thought in students as well as accurate assessment by teachers of students' ability to grasp key concepts.[2]

Despite the proven effectiveness of the case study method in the instruction of some of the most revered members of society, such as lawyers, doctors, and business executives, the DOD is woefully behind in employing this method. While the Defense Department has grown to utilize guided discussions and other forms of less-traditional learning, the default method of instruction is still lecture, followed by demonstration, followed by practical application, if applicable. The DOD, however, requires more recorded case studies in order to apply this effective method of teaching within DOD schools. More specifically, it requires an increased number of case studies that record organizational change as well as technological innovation. The Executive TANG provides an opportunity to add to the DOD's library of case studies. In order to develop a case study based on the events leading up to, during, and after the Executive TANG, the researchers will utilize Yin's six-step model as their primary guide along with Robert Stake's The Art of Case Study Research.

C. PREVIOUS RELATED RESEARCH

This thesis represents the third in a series of TANG-related theses from students at the Naval Postgraduate School. Each research effort examined a different aspect of the overall TANG initiative. The sections to follow present the findings of the previous research efforts.

1. The Original TANG Case Study (LCDR Hall)

The first in the series of Tactical Advancements for the Next Generation (TANG)-related research from the Naval Postgraduate School, authored by Lieutenant Commander (LCDR) Thomas Hall, is a case study with supporting analysis examining how design thinking and participative collaboration contributed to producing actionable technological innovation for the Submarine Force. "A Case Study of Innovation and

[2] Thomas, *How to Do Your Case Study*, Preface X.

Change in the U.S. Navy Submarine Fleet" describes the TANG Forum as an initiative driven by a few key actors within the submarine community to break the normative processes that govern technological advancement in the submarine force. With the involvement of IDEO and the support of Admiral (ADM) John Richardson, current Director of Naval Reactors (NR), it was the goal of the first TANG to capitalize on the creative potential inherent in design thinking. By conducting design thinking sessions among junior levels of submarine operators and leadership, new, innovative, and viable technological innovations emerged—innovations that will capture the technical skills and paradigm-shifting potential of the newer generation of operators not yet fully indoctrinated into submarine culture.

The genesis of TANG was a 2010 white paper, written by Josh Smith of the Applied Physics Lab at Johns Hopkins University, an organization tightly linked to the submarine community. As a former submarine officer, Smith wrote of his frustration with innovation in the submarine community and his concern that the Navy was hemorrhaging innovative ideas as junior personnel left the service. Now a civilian, Smith envisioned an environment for junior personnel with good ideas to communicate openly and collaboratively for the betterment of the fleet. The concept contained in the white paper initially caught the attention of a few key proponents: Mr. Pete Scala of Integrated Warfare Systems 5A (IWS 5A) and Commodore Bill Merz of Submarine Development Squadron TWELVE (DEVRON-12). Recognizing the potential to add fleet users' voice to the technology-development processes currently in use, they briefed Smith's idea contained in the white paper to then Vice Admiral (VADM) John Richardson, Commander of Submarine Forces (COMSUBFOR). While commanding the U.S. relief operation in Haiti following the 2010 earthquake, the Admiral developed an appreciation for the innovative capabilities of the civilian sector. In Smith's white paper, Richardson recognized an opportunity to bring those innovative capabilities to his force. With support from the top, Smith's ideas evolved into what eventually became the TANG Forum.[3]

[3] Thomas J. Hall, "A Case Study of Innovation and Change in the U.S. Navy Submarine Fleet" (master's thesis, Naval Postgraduate School, 2012).

The first TANG Forum was held in November 2011 with junior personnel representing the officer, Sonar Technician, and Fire Controlman communities—those principally involved in operating the tactical systems aboard the submarine. Over 3 days in San Diego, CA, 27 sailors participated in IDEO's design thinking process. Coached by IDEO and facilitated by Smith and his team, these sailors produced numerous innovative ideas, two of which are scheduled for introduction into the submarine fleet in Fiscal Year 15.[4]

Throughout the TANG Forum, the junior personnel that were directly involved in the design thinking process were observed by senior personnel in another room over an audio/visual link. This was done for two main reasons, 1) to keep the senior leaders from influencing the creativity of the junior personnel and 2) to allow the senior leaders to directly observe the process so that they could better understand the eventual outputs.[5]

Deemed an "amazing success" by ADM Richardson, the TANG Forum and its outputs were validated by introduction to the fleet.[6] Design thinking and the IDEO method could indeed be used by junior submariners to innovate technology and processes in a manner that would not be permissible or even possible under established cultural conditions. The decision was made to extend the TANG Forum to submarine commanders to address some of their challenges. Thus, the Executive TANG was born. Originally scheduled for February 2013, it was postponed until September 2013 due to funding constraints.[7] The Executive TANG will serve as the foundation of the case study to be developed through this research.

2. Leveraging the Millennial Generation to Influence Innovation (Major Gavin)

In research efforts closely related to those of Lieutenant Commander Hall described in the previous section, Major (Maj) Michael Gavin analyzed the underlying

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[4] Hall, "A Case Study of Innovation and Change in the U.S. Navy Submarine Fleet."

[5] Ibid.

[6] Vice Admiral John Richardson, *"TANG"–A Vision for the Future.* January 17, 2012, http://comsubfor-usn.blogspot.com/2012/01/tang-vision-for-future.html (accessed May 17, 2013).

[7] Hall, "A Case Study of Innovation and Change in the U.S. Navy Submarine Fleet."

theme of the initial TANG Forum: "leveraging the millennial generation sailor's seemingly innate familiarity and proficiency with technology" to improve end-user satisfaction, as well as tactical capability, by capitalizing on design thinking to bridge gaps between traditional requirements-based acquisition practices and the users who must actually employ submarine systems in combat.[8]

Sponsored by the Acquisition Research Program at the Naval Postgraduate School, Major Gavin cataloged the events within the various acquisition and program management offices, going back as far as the early-1990s, which permitted a radical idea like TANG to gain traction and produce results. Then, relating those events to Kotter's 8-step model, Gavin described how key actors ushered in critical changes to the established practices of the submarine acquisition programs. The result was an appreciation of the strength of collaboration and peer review as integral to producing quality, useful technology.[9]

Gavin's research chronicles the development of the Acoustic Rapid COTS (commercial off-the-shelf) Insertion (ARCI, pronounced ar-kee) program that replaced the traditional in-house development of sonar systems by Navy laboratories with a program that sourced competitive technology from the commercial sector. Still in use today and undoubtedly successful, ARCI was not born quickly or easily. It took persistent effort from key organizational actors to convince the traditional hierarchy of the submarine acquisition community that COTS technology was relevant, useful, and appropriate, and could be introduced in a manner that allowed the fleet to maintain acoustic sonar superiority at a consistent pace that was much faster than traditional methods.[10]

Though ARCI was successful at providing technological innovation at a rapid pace, it had unintended consequences, namely, that the training and support elements could not keep pace with the rapidity of technological change. This naturally led to

[8] Michael Gavin, "A Case Study of Managing Information Technology through Design" (master's thesis, Naval Postgraduate School, 2012).

[9] Ibid.

[10] Ibid.

resistance efforts on the part of entrenched actors within those affected communities. The efforts of those resistors eventually led to a moderation of the full capabilities of the ARCI program. Rather than providing upgrades and insertions at the pace of development, the program was purposely slowed to allow the support elements to remain effective at training and fielding a combat-capable crew. While certainly an important concern, the slowing of the introduction of technology solely in the name of training and familiarity begged the question of why such training took so long and was so intense. Could the fleet field more-intuitive technology that required less training and delivered a more usable interface?[11]

This, to both Gavin and Hall, is the crux of the many questions eventually leading to the TANG initiative. Gavin contends that design thinking methodology offers a "reproducible means to foment contextual understanding" between disparate stakeholders. In this case, those stakeholders are the acquisition professionals, engineers, and scientists tasked with developing future submarine technology and the users who must employ those products at sea, under arduous conditions. To Gavin, TANG offers a platform by which users can express ideas in a manner that enhances the ability to communicate those needs to the acquisition community, which then must translate those ideas and needs into the traditional requirements-based language that continues to drive the acquisitions process. In other words, TANG offers a forum to better communicate the needs of the fleet operator in a manner than can be dissected and digested more easily by engineers who must design and build the requested product. By taking input from those who will employ future technology, rather than from a specification contained in a requirements statement, the likelihood that a superior product emerges is greatly increased.[12]

Gavin predicated his thesis on observations from the initial TANG Forum described within Hall's research, in which IDEO employed a design thinking methodology amongst a group of junior officers (JOs) and petty officers—all members of

[11] Gavin, "A Case Study of Managing Information Technology through Design."

[12] Ibid.

the "digitally native" millennial generation.[13] The question remained, at the time of Gavin's writing, whether those methods would prove equally effective when applied to a group of experienced, senior leaders at the Executive TANG.

D. PROBLEM STATEMENT

The DOD does not have sufficient case studies based on successful technological change implementation. The U.S. military has done well innovating in the deployed environment due to pure necessity derived from extreme operational demands. It has, however, a poorer track record of innovation when not in a forward-deployed and austere setting. Technological innovation is crucial if the DOD is to maintain relevance as it moves forward into a world of increasing technological advancement.

E. PURPOSE STATEMENT

The purpose of this research is to produce a technological innovation case study that will allow DOD leaders to hone skills in implementing organizational change. As the DOD moves forward into a period of technological development in concert with a fiscally constrained defense environment, it will be essential for DOD leadership to understand how to technologically innovate.

F. RESEARCH QUESTIONS

The research will explore how the Executive TANG Forum utilizes participative design thinking to develop innovative solutions to problems in the submarine community. The case study will have particular emphasis on the involvement of mid-level leadership in the design process, with additional emphasis on the role played by IDEO, the external support agent. The following two research questions will be addressed:

- What are the benefits and other implications of utilizing a participative, design thinking process within the DOD?
- How can the benefits of design thinking be extended to mid-level managers in the DOD?

[13] Ibid.

G. RESEARCH METHODS

Both primary and secondary research will be used for this study. Through observation of the Executive TANG Forum as well as interviews with key participants, the researchers will develop a holistic case study of the process and outcomes of the innovation conference.

H. PROPOSED DATA OBSERVATION AND ANALYSIS METHODS

The qualitative approach to research will be utilized to produce the case study. To capture the event and transform it into a learning tool, the case study method is the most appropriate approach for this research. The researchers will observe participants in the conference and conduct interviews to obtain multiple perspectives of the process and relationships within the conference.

I. POTENTIAL BENEFITS AND LIMITATIONS

The primary benefit of this case study is increased understanding of organizational change and design thinking as it relates to technical innovation within the DOD. Additionally, this research will improve the ability of Defense leadership as mid-level managers utilize the case study as a tool to learn the design thinking process. The main limitation of completing a case study is the potential for biased writing as a result of the researchers' involvement in the events of the case. To mitigate this limitation, the researchers will collect data from multiple sources and ensure that no outlying opinions are completely negated.

II. LITERATURE REVIEW

A. INTRODUCTION

The researchers gathered the information used in this chapter through an extensive literature review of all required conceptual categories. Considerable time was spent reviewing material on case study methodology, organizational change, design, and design thinking as well as previous theses related to the Executive TANG Forum. As the research progressed, it became clear that this case would focus on issues related to change management and design thinking. This literature review was therefore guided primarily by those two areas and will serve as a basis for comparison and contrast during the case study's analysis.

B. THE CASE STUDY METHOD

The case study has become a popular and effective tool used by most business and management schools as well as leadership courses throughout the world. Simply defined, a case study is "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident."[14] According to Gary Thomas, the case study "provides the most vivid, the most inspirational analysis that an inquiry can offer."[15] Case studies are effective in teaching change management and leadership principles because they immerse the reader in the particular situation, giving the student a feeling of similar experience to that in the case study. When compared to the traditional lecture-style instruction, case studies are more effective at promoting critical thought from students as well as accurate assessment from teachers on students' ability to grasp key concepts.[16]

When asking whether the case study method is appropriate, one's choice depends largely on his or her research questions; the more the research questions seek to explain

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[14] Robert K. Yin, *Case Study Research: Design and Methods* (Thousand Oaks: Sage Inc., 2009), 18.

[15] Thomas, *How to Do Your Case Study*, Preface X.

[16] Ibid.

"how" or "why" a social phenomenon works, the more the case study method will be relevant.[17] The Executive TANG provides an opportunity to add to the DOD's library of case studies as the researchers attempt to explain "how" and "why" this innovation effort was successful or unsuccessful. In this effort, the researchers' second research question, "How can the benefits of design thinking be extended to mid-level managers in the DOD," lends itself perfectly to utilizing the case study method. In order to develop a case study based on the events leading up to, during, and after the Executive TANG, the researchers will utilize Yin's six-step model as their primary guide along with Robert Stake's The Art of Case Study Research.

According to Robert Yin, who is viewed by many as one of the experts in case study research, using case studies for research purposes is one of the most challenging of all social science endeavors.[18] Some view this method as a less than desirable form of research typically, due to the possibility that researchers can produce a less than adequate product resulting from sloppy research, lack of systematic procedures, or allowing biased views to influence the direction of findings and conclusions.[19] Despite these challenges, the case study method is appropriate when attempting to understand a real-life phenomenon in depth.[20]

Each and every research design requires conceptual organization, ideas to express needed understanding, conceptual bridges from what is already known, cognitive structures to guide data gathering, and outlines for presenting interpretations to others.[21] Robert Yin takes this theory a step further and advocates the following six-step linear but iterative process for systematically constructing an effective case study:

1. Plan
    a. Identify research questions
    b. Decide to use the case study method

[17] Yin, *Case Study Research*, 4.

[18] Ibid., 3.

[19] Ibid., 14.

[20] Ibid., 18.

[21] Robert E. Stake, *The Art of Case Study Research* (Thousand Oaks: Sage Inc., 1995), 15.

c. Understand strengths and limitations of case study research

2. Design
    a. Define the unit of analysis and case to be studied
    b. Develop theory, propositions, and issues underlying the study
    c. Identify the case study design (single, multiple, holistic)
    d. Define procedures to maintain case study quality
3. Prepare
    a. Hone skills as a case study investigator
    b. Train for specific case study
    c. Develop case study protocol
    d. Conduct pilot case
    e. Gain approval for human subjects protection
4. Collect
    a. Follow case study protocol
    b. Use multiple sources of evidence
    c. Create case study database
    d. Maintain chain of evidence
5. Analyze
    a. Rely on theoretical propositions
    b. Consider any of five analytic techniques
    c. Explore rival explanations
    d. Display data apart from interpretations
6. Share
    a. Define audience
    b. Compose textual and visual materials
    c. Display enough evidence for reader to reach own conclusions
    d. Review and re-write until done well[22]

As mentioned earlier, the major factors that can contribute to a poor case study are sloppy research, lack of systematic procedures, and/or allowing biased views to influence the direction of findings and conclusions. Following Yin's six-step process will

[22] Yin, *Case Study Research*, 9–164.

ensure the research is neat and systematic. Avoiding personal bias, however, will require additional rigor. If a researcher seeks only to do a case study to substantiate a preconceived position, the study will be unjustly biased; since case study researchers must understand the issues before hand, they are especially prone to this pitfall.[23] One test to check the level of bias is to assess the degree to which you are open to contrary findings—if you cannot accept a conclusion that conflicts your original stance, you will unduly bias the case study.[24]

An important control measure researchers can heed to protect conclusions from undue bias is to collect data from multiple types and numbers of sources.[25] The six sources of case study evidence include documentation, archival records, interviews, direct observations, participant observation, and physical artifacts but as Yin mentions, not all six sources are relevant for all case studies.[26] While some research techniques may rely on a single source of evidence, this technique is not recommended for case study research due to the preconceived notion that research may be biased.[27] Instead, using multiple sources of evidence allows case study researchers to triangulate on converging lines of inquiry, thereby lending credibility and validity to conclusions made.[28] In the Executive TANG case study, researchers will primarily use interviews, direct observations, and participant observations to triangulate on key elements.

While adequate emphasis should be placed on all six steps, the final step of the process, the share phase, requires special care as it will yield the final product. This phase can be the most demanding on the researchers because it requires conveying significant points, painting a complete picture for the reader, considering alternate perspectives, displaying sufficient evidence, and writing in an engaging manner in order to “hook the

[23] Yin, *Case Study Research*, 72.

[24] Ibid., 72.

[25] Ibid., 124.

[26] Ibid., 114.

[27] Ibid., 114.

[28] Ibid., 114–116.

reader."[29] One often overlooked pitfall in writing the report is lack of conciseness—according to Robert Stake, author of The Art of Case Study Research, a 20-page case study can quickly run to 50 if the researchers do not "ruthlessly winnow and sift."[30] While the reader should be counted on to do their share of the work to arrive at key conclusions, the case study writers must organize the case with the readers in mind.[31] While these requirements may seem daunting, by approaching the final phase with a systematic approach similar to the one used in the other five phases of Yin's six-step model, researchers can ensure the quality of their final product.

Despite the proven effectiveness of the case study method in the instruction of some of the most revered members of society, such as lawyers, doctors, and business executives, the DOD is woefully behind in employing this method. While the Defense Department has grown to utilize guided discussions and other forms of less traditional learning, the default method of teaching is still lecture, followed by demonstration, followed by practical application, if applicable. The DOD, however, requires more recorded case studies in order to apply this effective method within DOD schools. More specifically, it requires an increased number of case studies that record organizational change as well as technological innovation.

The previous section was devoted to explaining the case study methodology, as it will serve as the basis for the development of the Executive TANG case study. The subsequent sections of this chapter are devoted to providing the reader with a conceptual understanding of the two primary fields of research that interact in the case: organizational change management and design thinking. Organizational change management attempts to understand the complex dynamics occurring within organizations experiencing change while design thinking is devoted to finding solutions to difficult problems by harnessing the creative energy inherent to group dialogue.[32] The

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[29] Yin, *Case Study Research*, 185–189.

[30] Stake, *The Art of Case Study Research*, 121.

[31] Ibid., 122.

[32] Tony Golsby-Smith, "The Second Road of Thought," in *Rotman on Design*, ed. Roger Martin and Karen Christensen (Toronto: University of Toronto Press, 2013), 41–43.

dynamic relationship between these two interacting fields provides the conceptual foundation for the analysis of the Executive TANG case study.

C. ORGANIZATIONAL CHANGE MANAGEMENT

1. Introduction

Understanding and coping with change is a fundamental requirement for any organization to be successful over a long period of time. As the factors influencing an organization—be they economic market forces, the social attitudes of a constituent population, or the weapons systems of potential adversaries—change, organizations must navigate a changing world with corresponding adaptations to their internal functions, core processes, and relationships. To be successful in these endeavors, organizations and their leaders must have a frame of reference for planning and executing change.

In the sections to follow, the researchers will explore the varying theoretical perspectives of change management. From the foundational theorists who emphasized rapid, linear, planned change to some contemporary theorists who present a less-procedurally driven model, the researchers will offer differing frameworks to understand the change efforts of the submarine community and the potential future effects of the TANG initiative.

2. Foundational Change Theorists

a. Kotter's 8-step Process

According to John Kotter, one of the foundational theorists in the area of organizational change management, there is an inevitable downside to any change effort. Some of this downside, however, can be avoided if the most common errors in instituting change are known.[33] In his book *Leading Change*, he outlined these common errors that must be avoided to increase the likelihood of successful change implementation: not establishing a great enough sense of urgency, not creating a powerful enough guiding coalition, lacking a vision, under-communicating the vision by a factor of 10, not removing obstacles to the vision, not systematically planning for and creating short-term

[33] John Kotter, *Leading Change* (Boston: Harvard Business School Press, 1996), 4.

wins, declaring victory too soon, and not anchoring changes in the corporation's culture.[34] In a less-competitive world, these errors would not be as detrimental as they are in today's more-competitive environment.[35] Given the volatility of today's workplace, however, committing these errors can lead to serious consequences such as new strategies not being implemented well, acquisitions failing to achieve expected synergies, re-engineering taking too long and costing too much, uncontrolled downsizing, and quality programs failing to deliver expected results.[36]

In order to combat the pitfalls listed above and subsequent consequences, Kotter developed his renowned 8-step process for implementing organizational change:

1. Establish a sense of urgency
2. Create the guiding coalition
3. Develop a vision and strategy
4. Communicate the change vision
5. Empower broad-based action
6. Generate short-term wins
7. Consolidate gains and produce more change
8. Anchor new approaches in the culture[37]

This process is Kotter's prescription for holistic organizational change. It is sequential and requires adherence to its step-by-step nature as well as diligence in not skipping or rushing steps, as mistakes in one area of the process can cascade to affect the outcome of the effort as a whole.[38] To provide additional focus and guidance to change agents, Kotter divides the eight stages into three conceptual areas. Steps 1 through 4 deal with preparing the organization for change. Steps 5 through 7 are the actual

[34] Kotter, *Leading Change*, 4–14.

[35] Ibid., 15.

[36] Ibid., 16.

[37] Ibid., 21.

[38] Ibid., 21.

implementation of the change itself. Step 8 is where change takes root and becomes lasting.[39]

Due to the difficult nature of any change effort, the process was constructed using 8 steps, understanding that it would be lengthy and taxing for leadership. These 8 steps, however, are necessary instead of fewer broader steps because of the emphasis needed on proper execution of each critical component of the process. According to Kotter, proper implementation of the 8-step model will greatly increase the likelihood of successful organizational change. Other foundational theorists, however, have developed less-prescriptive models for successful implementation of change.

b. Planned Change: Unfreeze, Change, Refreeze

First elaborated by Lewin and later advanced by Schein, planned change theory attempts to offer a comprehensive theory to explain the execution of an intentional change effort. While acknowledging that the emotional responses of individuals involved in change efforts are immensely complex, planned change theory nevertheless offers three relatively simple, sequential steps that account for the change process from end to end: unfreeze, change, and refreeze.[40]

Unfreezing involves stimulating the need for change by highlighting the inadequacies of the current situation, thereby stimulating a desire for change. This begins by disconfirming present behavior in order to challenge the validity of an individual's present worldview. Challenging and disconfirming will necessarily result in some amount of anxiety on the part of those now threatened. The degree to which anxiety is present, however, is important for the process to continue, as conditions must be sufficiently uncomfortable to motivate a genuine desire for change. Once the subjects of the change effort are properly motivated through discomfort or fear, it is imperative that change agents then provide a psychologically safe environment that is reassuring of individuals' capabilities and efforts to change.[41]

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[39] Kotter, *Leading Change*, 22.

[40] Edgar Schein, *Organizational Psychology* (Englewood Cliffs, NJ: Prentice-Hall, 1980), 247.

[41] Schein, *Organizational Psychology*, 247.

The change phase involves the installation of new conditions by re-defining individuals' cognitive processes. This is a complicated and often lengthy process during which an individual must be shown that new conditions provide for a more positive outcome than adherence to previous methods. Either through observation of a respected mentor or through "scanning" of the environment for relevant information to confirm the validity of the new methodology, the individuals involved in the change process must re-define the way they perceive their world. For change to truly be effective and long-lasting, individuals must alter the way they perceive concepts and information related to the change at hand. Information that once resulted in a certain response under previous conditions must now be processed differently, according to a new mental model that meets the requirements of the new situation.[42]

Critical to the overall process is the final step of refreezing. It is not sufficient to simply induce or foster change through the above methods and not follow through to ensure long-term adoption. Relapsing to previous behavior is very common in change efforts, due mostly to actions on the part of others that disconfirm the change. This results in the same anxiety that sparked the adoption of new behavior. Looking to alleviate this anxiety, individuals often seek the comfort of previous conditions, thereby emphasizing the importance of the refreeze step.[43]

Preventing relapse can be aided by allowing individuals processing change to experiment and test methods that may prove to be better suited to their unique personalities, yet achieve the same results. Rather than mandating strict adherence to certain behaviors or suggesting the imitation of others' success, change agents should allow a certain amount of experimentation and flexibility to permit a tailored solution that will ultimately prove more successful and long lasting. When individuals refreeze in this manner, conditions are more appropriate for the fundamental shifting of cognitive processes that is essential to secure long-lasting change.[44]

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[42] Ibid.

[43] Ibid., 248.

[44] Schein, *Organizational Psychology*, 44.

3. Contemporary Change Theory

a. Rapid Change to High-Impact Elements

Kotter emphasizes establishing a sense of urgency and creating a broad-based coalition of action in steps 1 and 5 of his 8-step process.[45] Arguing against the notion that rapid change efforts yield superior results, John Amis, Trevor Slack, and C.R. Hinings present findings that suggest otherwise.[46]

Examining the results of data collected over a 12-year period regarding how organizations implemented directed change from an outside actor (specifically, in this case, how national sports agencies in Canada implemented government-mandated changes to organization structure), Amis et al. conducted a quantitative study in order to validate their hypotheses. Amis et al. focused on three aspects of change: pace of change, sequence of efforts, and linearity of implementation. Initially, the authors set out to prove three hypotheses: "the completion of a radical organizational transition is characterized by a rapid change of pace, a change sequence that involves early change to high-impact organizational elements, and that elements in an organization undergoing a radical transformation will change in a non-linear manner."[47]

The authors' findings with respect to pace are contrary to the traditional wisdom, actually disproving their first hypothesis that rapid change is superior. This view, grounded in the notion that rapid change engenders resistance to the change itself rather than the actors imposing the change, is designed to shield the change agent from protracted, long-lasting battles with powerful, embedded actors. Amis et al. found that *rapid change alone will not bring about successful results* and may actually prove detrimental as the shock of wholesale rapid change may paralyze an organization. Instead, they suggest *targeted change to high-impact functions, implemented rapidly, followed by a period of sedation* to allow the changes to take hold and the organization to

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[45] John Kotter and Leonard Schlesinger, "Choosing Strategies for Change," *Harvard Business Review* 86, no. 7 (July–August 2008).

[46] John Amis, Trevor Slack and C.R. Hinings, "The Pace, Sequence, and Linearity of Radical Change," *Academy of Management Journal* 47, no. 1 (February 2004): 15.

[47] Ibid.

adjust to new processes and relationships. The critical element of their findings is geared toward the sequence of efforts rather than the pace of implementation. The authors posit that the sequence of change, targeting high-impact, important organizational elements first, then proceeding to less-impactful functions at the periphery of the organization, allows for the establishment of trust among those affected and also signals that changes are real and long-lasting, and that required adjustments are not optional. Allowing time for these realizations to occur and the required alternative action to develop is essential and directly combats the notion that rapid implementation is the panacea to engender successful change.[48]

Lastly, Amis et al. tackle the linearity of change. Traditional theory holds that change is a linear process, occurring at a relatively constant rate and affecting an organization in a pre-determined manner. They find that this is not the case. Rather, *change is occurring within different parts of an organization at different rates* and with varying success. Characterizing change as "a series of oscillations and reversals," the authors caution against assuming that external change will be easy to accomplish according to an implementation plan. Change actors must instead accept the reality that unsuccessful attempts will occur along the path of implementation. The ability to persevere through these times and accept the possibility that full reversal may occur for periods of time is essential to those wishing to alter the most high-impact and valuable organizational functions. The work by Amis et al. provides a framework from which to view external change efforts. The section to follow presents an alternative view of successful change implementation at the hands of internal vice external actors.[49]

b. Incremental Change by Embedded Actors

In their 2006 work entitled *Legitimizing a New Role: Small Wins and Microprocesses of Change*, Trish Reay, Karen Golden-Biddle, and Kathy Germann combat the notion that organizational change is solely a function of external events or outside actors. They focus their analysis on the concept of *actor embedded-ness*, which is

[48] Amis, Slack, and Hinings, "The Pace, Sequence, and Linearity of Radical Change," 15.

[49] Ibid.

the degree to which any actor within an organization is embedded within the existing organizational culture and social context. Going beyond simple longevity, embeddedness implies a visceral understanding of the complex social and interpersonal relationships that provide the social contexts that drive the daily actions of those within an organization. *Through an innate understanding of relationships, highly embedded actors may influence change efforts in manners that non-embedded actors may not grasp due to their inability to perceive social subtleties that represent the most powerful avenues to engender successful, lasting change.*[50]

An understanding of embedded actors versus non-embedded actors has long been a tenet of change theory. Reay et al., however, focus on the opposite side of the traditional view of embedded-ness, which holds that the longer an actor has functioned within a given organizational culture, the more embedded they become, resulting in an inability "to recognize the need for change and take action accordingly." In other words, the traditional view of embedded actors is one of reticence and resistance to change due to their comfort within the established social norms of the current culture.[51] The authors offer an alternative view of embedded-ness as an "opportunity" vice a "constraint," a powerful tool that is capable of profoundly affecting the social and organizational culture of a system from within. The authors identify three "micro-processes" by which embedded actors may harness the strength of their position within the social construct.[52]

(1) Cultivating opportunities for change. Remaining alert and sensing the "right time" to seize upon an opportunity presented by the course of normal events to advance a change agenda, this process leverages the sensitivity of the embedded actor to relationships within the social context. The embedded actor uses his or her innate understanding of factors affecting an organization to sense the proper opportunity to move efforts forward. These factors may be internal, external, budgetary, or social. Critical to the success of the embedded actor is sensitivity to how small factors, beyond

[50] Trish Reay, Karen Golden-Biddle, and Kathy Germann, "Legitimizing a New Role: Small Wins and Microprocesses of Change," *Academy of Management Journal* 49, no. 5 (October 2006): 994

[51] Ibid., 978.

[52] Ibid., 984.

the control of the organization itself, pressurize the organizational culture in a manner that presents an opportunity to create desired change. “Rather than focusing on one major opportunity, [embedded actors] pepper the landscape with many cultivated opportunities.”[53]

(2) Fitting the role into the prevailing system. Removing system barriers is the essential element of this step in the process. Doing so requires an understanding of what those barriers are, whether caused by other actors within the system or factors external to the organization. Here, the advantage to the embedded actor is an *awareness* of regulatory or policy barriers and, conversely, how to leverage those same avenues to codify or entrench the new process within guiding doctrine—thus making the new process or role hard to remove later. Further, embedded actors are able to identify powerful actors in other parts of the organization who may serve as allies in solidifying change through indirect methods. In the authors’ words, embedded actors “know who can help them and who will not.”[54]

(3) Proving the value of the new role. The final micro process addresses proving the value of the proposed change, convincing those who need to be convinced and motivating those who already are. Embedded actors are capable of operating with “context appropriate” methods to accomplish their goals. Where non-embedded actors may choose an inappropriate change strategy out of cultural ignorance, the embedded actor understands exactly how to communicate their vision of the future in a manner that resonates with others in the organization, increasing the likelihood of gaining allies and support. This micro-process requires diligent attention and persistence as resistors are not generally easily or quickly convinced to change their views.[55]

Contrary to traditional theory, the authors argue that embedded actors can improve the likelihood of successful organizational change. By integrating their new ideas into the existing organizational culture, they can influence others in subtle, less-perceptible ways.

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[53] Reay, Golden-Biddle, and Germann, “Legitimizing a New Role,” 986.

[54] Ibid., 988.

[55] Reay, Golden-Biddle, and Germann, “Legitimizing a New Role,” 989.

c. Radical, Continuous Change

The traditional view of radical change to core processes of an organization is heavily biased toward the view that radical change must be introduced quickly and with a clear sense of purpose. This view holds that change introduced incrementally or lacking clear vision of the end state is doomed to failure as efforts will be mired in resistance until they are eventually derailed. Donde Plowman and her team describe a case in which radical, fundamental change occurred within an organization as the outcome of continuous, small-scale actions that accrued over time to produce large-scale results. In this way, change can be both continuous and radical.[56]

In order to explain their observations, Plowman et al. rely on complexity theory as an analytical framework. They view change agents as singular or small sets of local actors acting in parallel but absent central coordination of effort. The interactions of their uncoordinated efforts produce a complex organization in which "perpetual novelty" takes root.[57] Actions by one actor are perpetuated and compounded by the actions of another, quite possibly by accident. Over time, the compound effect is capable of producing large-scale organizational change that is often imperceptible while the smaller changes are occurring.[58]

The critical theoretical element advanced by their research is that *change can indeed be both radical and continuous*. Continuous implies an opposite view of radical change as purely revolutionary in nature—occurring swiftly and with purposeful action. Plowman et al. detail conditions in which small, unrelated actions taken at lower levels of an organization can unintentionally engender radical change.[59]

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[56] Donde Ashmos Plowman, Lakami T. Baker, Tammy E. Beck, Mukta Kulkarni, Stephanie Thomas Solansky, and Dedandra Villareal Travis, "Radical Change Accidentally: The Emergence and Amplification of Small Change," *Academy of Management Journal* 50, no. 3 (June 2007): 515.

[57] Ibid., 519.

[58] Plowman, Baker, Beck, Kulkarni, Solansky, and Travis, "Radical Change Accidentally," 540.

[59] Plowman, Baker, Beck, Kulkarni, Solansky, and Travis, "Radical Change Accidentally," 539.

d. Small Wins

As an extension of their research into the importance of actor embedded-ness in *Legitimizing a New Role: Small Wins and Microprocesses of Change*, Trish Reay and her fellow researchers describe the power of achieving small wins when attempting to tackle large-scale organizational change. In such efforts, where goals are far reaching or cultures firmly entrenched, attempting to radically or quickly engender change will be noticeable to resistors, likely resulting in change efforts being co-opted by institutionalized opponents. Reay et al. found that scaling down expectations and pursuing a strategy of small wins, achieved in serial and directly related to both one another and the overall goal, will achieve the same results in a manner less likely to be conspicuously threatening.[60]

Beyond the value of small wins as camouflage, they also offer opportunities to motivate and sustain persistent, long-term change. Using a small wins strategy implies a long-term change effort focused on systematically and persistently chipping away at resistance. This requires dedicated change agents who may find themselves frustrated and stymied by the magnitude of the task at hand. Understanding that change agents will need motivation to continue, leaders of change must highlight each small win as proof that their efforts are valuable and productive. In this way, *small wins are self-sustaining in that they engender change while simultaneously motivating continued effort by change agents.*[61]

With each small win, the future that once seemed difficult to imagine is made ever more concrete. This calcification, however slow and incremental, leverages the passage of time, making the past more and more distant and forgettable while ushering in, inconspicuously, a new future representing the desired outcome of the change effort.[62]

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[60] Reay, Golden-Biddle, and Germann, "Legitimizing a New Role," 994.

[61] Ibid.

[62] Reay, Golden-Biddle, and Germann, "Legitimizing a New Role," 994.

e. The Leader as Sense-maker

Many of the themes that have been explored in this section center around the notion that new, emergent requirements or changes to organizational context will necessarily require a response from leadership. Traditionally, proper responses from leadership to change have been envisioned to be of the "command and control" type.[63] That is, the leader develops a vision of the desired end state, maps a strategy to move in that direction, and then personally executes the plan with precision and attention to detail. While appropriate to some contexts, some theorists have asserted that this application of leadership is less appropriate when an organization is faced with change. Louise Grison and Mick Beeby state quite pointedly that the true exercise of leadership is actually one of *sense-making*: "If leadership is fundamentally about power and power is about the ability to define situations with and for others then the exercise of power becomes the exercise of sense-making."[64]

Echoing Grison and Beeby in their case study of radical, continuous change, Plowman et al. offer the following: "we saw the important roles that leaders played as 'sense-makers', using the tools of language and symbols to give meaning to the changes that were happening in a way that provided coherence to the organization."[65] Through the related work of these authors, the emerging role of the leader during organizational turmoil has transformed from one of providing direct influence and active control to one of interpretation of the realities in which the organization finds itself. This directly confronts the traditional understanding of leadership as visionary and directive and becomes problematic for those who wish to define leadership as the act of creating or controlling the future. Grison and Beeby state that the "power over" paradigm of individualistic leadership is ineffective for organizations that are addressing complex

[63] Louise Grison and Mick Beeby, "Leadership, Gender, and Sense-making," *Gender, Work, and Organization* 14, no. 3 (May 2007): 193.

[64] Ibid., 194.

[65] Plowman, Baker, Beck, Kulkarni, Solansky, and Travis, "Radical Change Accidentally," 540.

problems because it is unnecessarily restrictive and removes options for collaboration and participative creativity.[66]

This is not to say that there are never times to appropriately employ highly directive, authoritarian, or hierarchical leadership styles and methods; it is rather to offer that this type of leadership may not be appropriate for organizations that are facing emergent challenges to the status quo. During these times, it may be more appropriate for the leader to function as a sense-maker, providing insight and guidance to their followers rather than tight control. In doing so, the leader frames problems in a manner that also invites participation and collaboration to achieve superior results, while simultaneously promoting adjustment to new realities on the parts of followers. This view is firmly rooted in the belief that good ideas bubble up from below and require leadership to contextualize good ideas rather than develop them in a singular fashion. In order to accomplish this, leaders must let go of the desire to actively control the future and view uncertainty and change as unavoidable opportunities to promote creativity and innovation among their constituent teams.[67]

4. Conclusion

The above sections have highlighted the differing views with respect to planning, executing, and understanding change efforts and their impact on an organization. As with change itself, there is no one correct method to employ that will ensure successful, long-lasting change as different theorists clearly have different views with respect to what can and should be done to achieve a positive outcome. Generally, traditional theorists emphasize a procedural, process-driven model that largely focusses upon the actions of a single, powerful, visionary change agent who leads change efforts through decisive action and aggressive implementation. Alternatively, contemporary theorists offer less-prescriptive models that focus on the small actions of relatively non-empowered change agents. These actors bring lasting organizational change via consistent small-scale action that compounds over time to produce large-scale results. In the contemporary theory

[66] Grison and Beeby, “Leadership, Gender, and Sense-making,” 195.

[67] Plowman, Baker, Beck, Kulkarni, Solansky, Travis, “Radical Change Accidentally,” 540.

presented above, leadership is less about singular visionary action to control the future and more about interpreting the meaning of current realities. In this manner, sense-making replaces strategy and bottom-up replaces top-down. A consolidated presentation of the comparisons between the theories presented in this section can be found in Table 1.

THEORETICAL ELEMENT	TRADITIONAL THEORY	CONTEMPORARY THEORY
Leaders	• Strategists • Visionaries • Guide change	• Sense-makers • Interpret situation using context-appropriate language
Actors	• Singular or comprising a single, powerful group or central coalition • Newly arrived, non-embedded	• Multiple, comprising broad action • Embedded within the social context of the organization • May not be coordinated
Action	• Broad, organization-wide • Created according to plan	• Specific, tailored • Opportunity driven
Force	• External	• Internal or external
Pace	• Rapid	• "Fits and starts" • May be rapid at times, slow and deliberate at others
Impact	• High • Affecting core-processes	• High or low, depending
End-state/Result	• Known • Derived from vision or strategy	• May be unknown
Process	• Linear • Procedural: unfreeze, change, re-freeze. • Prescriptive: 8-step model	• Non-linear • Incremental • May even be meandering or regressive at times
Wins	• Emphasize small wins	• Emphasize small wins
Emotional Response	• Threatening • Anxiety-driven	• Non-threatening • Often inconspicuous

Table 1. Comparison of elements of traditional and contemporary organizational change theory

While Table 1 is useful to categorize theoretical elements, it does not properly connote the true complexity of change once theory is put into practice as organizational change initiatives and their associated dynamics are not easily given to simple, condensed explanations or one-word solutions. The immense complexity that defines the modern world engenders an equally complex environment within today's organizations. All organizations are comprised of human beings performing functions and in this way small and large organizations alike are faced with similar challenges when looking to tackle the vexing problems that negatively impact their organizations. These are problems rooted in the interaction of the human beings that comprise organizations and are such that there are no correct answers.[68] There are, rather, infinite interpretations and, depending on one's view or opinion, infinite solutions. Renowned design theorist Horst Rittel coined a special phrase to define this type of problem: the wicked problem.[69]

D. WICKED PROBLEMS

Hard problems have always surrounded the world of business and academia alike. Solving differential equations or determining optimal stocking of a warehouse are difficult tasks to conquer. Institutions of higher learning, however, have taught us how to analyze hard problems and converge on a solution. Software developers have made fortunes designing and selling decision-support tools to assist in solution generation to solve hard problems. The problem is: hard problems are not the problem.[70]

Instead, the non-linear world in which we must thrive will be dominated by wicked problems as we progress into a future plagued by uncertainty and complexity. These problems are not just more difficult than hard problems. Wicked problems, first identified by mathematician Horst Rittel in the 1960s, are "a class of social system problems which are ill-formulated, where the information is confusing, where there are

[68] Karen Christensen, "Building Shared Understanding of Wicked Problems," in *Rotman on Design*, ed. Roger Martin and Karen Christensen (Toronto: University of Toronto Press, 2013).

[69] Roger Martin, *The Design of Business: Why Design Thinking is the Next Competitive Advantage* (Boston: Harvard Business Press, 2009), 94.

[70] Ibid.

many clients and decision makers with conflicting values, and where the ramifications in the whole system are ill-defined and unique in their causes, character, and solution."[71]

Dealing with wicked problems requires a different focus. Instead of focusing on the solution, you must devote substantial time to *understanding the nature of the problem itself*.[72] A wicked problem has one or more of the following characteristics:

- The causes of the problem are not just complex but deeply ambiguous; you cannot tell why things are happening the way they are and what causes them to do so.
- The problem does not fit neatly into any category you have encountered before; it looks and feels entirely unique, so the problem-solving approaches you have used in the past do not seem to apply.
- Each attempt at devising a solution changes the understanding of the problem; merely attempting to come to a solution changes the problem and how you think about it.
- There is no clear stopping rule; it is difficult to tell when the problem is "solved" and what that solution may look like when you reach it.[73]

Wicked problems will dominate the future. Problems like how to end poverty in Africa, how to reform our education system, and how to innovate in a traditionally hierarchal organization will require a new way of thinking. According to Richard Buchanan, "design thinking may be applied to any area of *human* experience" but is well suited to address wicked problems because design thinking is premised upon a lack of preconceived solutions: "[the task] for designers is to conceive and plan what does not yet exist…"[74] This is in contrast to the disciplines of science, which are concerned with understanding what already exists—the principles, laws, rules, or structures that are embodied in existing subject matters.[75] To address wicked problems, understanding what already exists will not be enough. Instead, leaders must become designers and foster an

[71] Martin, *The Design of Business*, 94.

[72] Ibid., 95.

[73] Ibid., 94.

[74] Richard Buchanan, "Wicked Problems in Design Thinking," *The MIT Press Design Issues* Vol. 8, no. 2 (Spring 1992): 18.

[75] Buchanan, "Wicked Problems in Design Thinking," 18.

environment conducive to "outside of the box thinking" where subordinates can *discover*—if they do not, wicked problems will prevail over the problem solvers of the world.

E. DESIGN THINKING

1. Introduction

While change management provides techniques for increasing the chance of success when instituting organizational change, something else is needed to actually figure out *what the change should be.* This is where design and design thinking are essential. In the 20th century, value creation was primarily derived from converting a *heuristic* into an *algorithm.*[76] Many 20th century companies thrived due to optimization efforts in the areas of supply chain management, cost controls, and warehouse control.[77] Similarly, in the DOD, increasing emphasis has been placed on business process optimization through efforts like Lean Six Sigma managerial concepts and reliance on operations research. Moving forward, however, optimization may not be enough. As a business or organization goes through the optimization process, at some point maximum effort will only produce marginal gains in performance because you are, in fact, approaching a fully optimized state. One senior executive with a major food company recently remarked, "In the early 2000s we became the most efficient food company in the world, but so have our main competitors. What now?"[78] According to Roger Martin, the world is on the cusp of a design revolution—competition in business is no longer about creating dominance in scale-intensive industries, but rather it is about *producing elegant, refined products and services in imagination-intensive industries*.[79]

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[76] Roger Martin, "Introduction to Rotman on Design," in *Rotman on Design*, ed. Roger Martin and Karen Christensen (Toronto: University of Toronto Press, 2013), 9.

[77] Ibid.

[78] Sohrab Vossoughi, "The Age of Meaning," in *Rotman on Design*, ed. Roger Martin and Karen Christensen (Toronto: University of Toronto Press, 2013).

[79] Martin, "Introduction to Rotman on Design," 9.

2. Foundational Design Theorists

a. Herbert Simon

Herbert Simon (1916–2001) was among the founding fathers of several of today's important scientific domains, including artificial intelligence, information processing, decision-making, problem-solving, attention economics, organization theory, complex systems, and computer simulation of scientific discovery.[80] In his book The *Sciences of The Artificial,* Simon wrote:

> Historically and traditionally, it has been the task of the science disciplines to teach about natural things: how they are and how they work. It has been the task of engineering schools to teach about artificial things: how to make artifacts that have desired properties and how to design. [However] Engineers are not the only professional designers. Everyone designs who devises courses of action aimed at changing existing situations into preferred ones.[81]

Out of this excerpt, a simple but foundational definition of design was articulated: Design is *transformation of existing conditions into preferred ones*.[82] Also in this book, Simon points out the irony of the 20th century; the natural sciences almost completely drove out the artificial sciences from professional school curricula. For example, engineering schools focused heavily on physics and mathematics, medical schools became schools focusing on biological science, and business schools concentrated on mathematical optimization.[83] The major disparity with this focus on the natural sciences is that personnel in fields such as engineering, medicine, business, architecture, and painting should not necessarily be concerned with *how things are* but rather *how they might be.*[84] That is to say, someone in one of these fields cannot simply study what exists—they must also *create* something that contributes to the continued advancement of that field. In short, they are concerned with design or the science of the artificial. While

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[80] "Herbert A. Simon," in Wikipedia: The Free Encyclopedia (Wikimedia Foundation Inc., updated July 2004, 10:55 UTC), http://en.wikipedia.org/wiki/Herbert_A._Simon; Internet (accessed December 22, 2013).

[81] Herbert Simon, *The Sciences of the Artificial* (Cambridge, MA: The M.I.T. Press, 1969), 55.

[82] Ibid.

[83] Ibid., 56.

[84] Simon, *The Sciences of the Artificial,* 56.

seeming at odds with one another, the science of the artificial is not meant to replace the natural science but rather to complement it.[85]

The crux of Simon's position is very simple: humans have a somewhat limited cognitive capacity for reasoning when searching for a solution within a problem space.[86] Though the human intellect is powerful, it begins to falter when faced with seemingly boundless options by which to solve a problem. While computers assist in providing greater capability, their capacity is still limited.[87] According to Simon, the first step in any problem-solving episode is *representing the problem*, and to a large extent, that action will reveal the solution hidden within the representation of the problem.[88] When dealing with wicked problems, it is especially important to heed this principle and focus efforts on understanding the nature of the problem itself.

b. Richard Boland

While Herbert Simon developed the first basic definition of design, Richard Boland was one of the initial authors who wrote literature focusing exclusively on design. In his 2004 book *Managing as Designing*, Boland argued that if leaders adopted a design attitude the world of business would be a better place.[89] He used the classic inventory control problem as a great example of where design thinking could have been beneficial. Modeling the inventory process as a buffer between customer demands and company production became the default for 30 years, which resulted in the development of techniques for calculating reorder points and lot sizes, and minimizing holding costs.[90] The focus on these complex calculations, however, led to being blinded for decades from

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[85] Ibid., 79.

[86] Richard J. Boland Jr. and Fred Collopy, *Managing as Designing* (Stanford: Stanford University Press, 2004), 9.

[87] Ibid.

[88] Boland and Collopy, *Managing as Designing*, 9.

[89] Ibid., 3.

[90] Boland and Collopy, *Managing as Designing*, 6.

other ways to minimize inventories such as rethinking the design of production processes, relationships with suppliers, and use of information systems that support the company.[91]

In his book, Boland identifies what he calls a *design attitude*. Using this term, he refers to the expectations and orientations one brings to a design project.[92] A design attitude views each effort or project as a chance for invention that includes a questioning of basic assumptions and a resolve to leave the world a better place.[93] According to Boland, designers relish the *lack of predetermined outcomes*.[94] That is to say, designers are not focused on optimization but instead focus their efforts on *what could be*.

In the introduction to this section on design thinking, the researchers articulated that design provides a highway to determine *what the change should be* while organizational change management increases the chances of successful implementation of a change. Boland takes this a step further and explains that the tools of traditional business planning start with the assumption that incremental growth will produce continued acceptable gains in performance.[95] What if, however, in the 21st century actions of the future can no longer be based on what happened in the past? Boland argues that certain tools from design can actually help organizations execute large-scale change efforts. More specifically, the design tools of *contextual observation, human-centered frameworks, and rapid prototyping* can be effective in helping businesses manage change.[96]

As evidenced in the 20th century, when managers focus heavily on quantitative and qualitative data, it sometimes becomes difficult for them to actually notice a solution to a problem that may be right in front of them.[97] This is because the data they are

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[91] Ibid.

[92] Ibid.

[93] Ibid.

[94] Ibid.

[95] Ibid., 188.

[96] Ibid., 189.

[97] Boland and Collopy, *Managing as Designing,* 189, 190.

exclusively relying on has typically been stripped of any emotional content.[98] Giving people the tool of *contextual observation*, a different way of seeing that reality, however, helps them to address the problem.[99] For example, if a civilian consultant company was hired to explore information flow within an exclusive military organization, it would be hard for that team of civilians to truly understand the nature of the problem unless they embedded themselves in the everyday life of that community and observed actors in the context of their day-to-day routines.

As more of the problems in the world become wicked in nature, it becomes difficult to look specifically at the effort of an *individual* business unit within an organization because more and more problems overlap multiple units. No longer can individual sections within a company be optimized to operate independently; they must work together seamlessly. According to Boland, designers create frameworks so that they can simplify and unify design opportunities in order to conceive possible futures and make certain that all parts and pieces are coordinated with one another.[100] These *human-centered frameworks* reintroduce a holistic viewpoint to an organization and allow them to refocus on providing value to the most important component of any organization—humans (e.g., customers, employees, and other stakeholders).[101]

According to Boland, the last design tool that can be applied to organizational change is rapid prototyping, which helps people to experience a possible future in tangible ways.[102] This technique allows a very low-risk way of quickly exploring multiple directions before committing resources (both time and material) to the best one.[103] Rapid prototyping can obviously be used for product development but can also be used to model an environment, enact processes and business plans, or even outline

[98] Ibid.

[99] Ibid.

[100] Ibid., 188.

[101] Ibid., 191.

[102] Ibid.

[103] Ibid.

information flow within an organization.[104] The major benefits to this technique are that it provides an opportunity to explore hunches or distant ideas that might in turn give more clarity to the problem, it helps organizations to be mindful of the possibilities of creating unique solutions, and it also allows for quick convergence and more useful feedback from stakeholders.[105]

c. Roger Martin

Roger Martin is revered by some as one of the most instrumental theorists of design and design thinking. According to Martin, designers take a mystery and turn it into a heuristic, then turn that heuristic into an algorithm, and finally turn that algorithm into binary code (if applicable).[106] A great example of this transformation is the study of gravity: the mystery was the observation of items falling, the heuristic was understanding gravity, understanding gravity resulted in the algorithm for the gravity constant (9.81 meters/second^2), and the algorithm then allowed the programming of binary code for aircraft autopilot.[107] In the 20th century, value creation was primarily derived from converting a heuristic into an algorithm.[108] Many 20th century companies thrived due to optimizations efforts in the areas of supply chain management, cost controls, and warehouse control.[109] In the 21st century, however, value is more likely going to be derived in a different way.

In his 2009 book *The Design of Business*, Martin explains why design thinking is the next competitive advantage for businesses. Martin articulates that very few companies are able to balance between exploration and exploitation to truly take a design-thinking approach.[110] Too often companies choose either exploration or exploitation and fail to

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[104] Boland and Collopy, *Managing as Designing*, 191.

[105] Ibid.

[106] Martin, "Introduction to Rotman on Design," 9.

[107] Ibid.

[108] Ibid.

[109] Ibid.

[110] Martin, *The Design of Business*, 19.

balance between the two.[111] Going back to Boland's inventory control example, focusing on calculating reorder points and lot sizes, and minimizing holding costs, focuses on exploitation while rethinking the design of production processes, relationships with suppliers, and use of information systems that support the company would focus on exploration. The best approach would be to balance between the two.

In order to capitalize on this next competitive advantage, organizational leaders must learn to reconcile between analytic and intuitive thinking.[112] The analytic thinking model is used to create value by driving out gut-feelings and instincts and instead relies on rigorous, quantitative analysis backed by decision-support software, if available.[113] Conversely, intuitive thinking is centered around creativity and innovation.[114] The two models are both with their strengths and weaknesses and while it seems that they do not complement each other, Martin actually proposes that neither analysis nor intuition alone is enough.[115] Similar to the balance between exploration and exploitation, the most successful businesses will balance between analytical mastery and intuitive originality in a dynamic interplay called design thinking.[116] According to Martin, design thinking is *the form of thought that enables movement along the knowledge funnel, and the firms that master it will gain a nearly inexhaustible, long-term business advantage.*[117]

The knowledge funnel, as depicted in Figure 1, pictorially shows how leading businesses should work to innovate most consistently and successfully. The mystery stage can take many forms but at its core it involves exploring an unknown—a medical researcher may explore the mystery of a learning disability or a military officer might delve into the nuances of information flow. When passing through the heuristic phase, the field of inquiry simply gets narrowed down to a manageable size—this stage provides a

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[111] Martin, *The Design of Business*, 20.

[112] Ibid., 5.

[113] Ibid.

[114] Ibid.

[115] Ibid., 6.

[116] Ibid.

[117] Ibid., 7.

simplified understanding of the mystery and allows the focusing of effort. That same military officer looking into the mystery of information flow might narrow that down to information flow on a nuclear submarine in this stage and map out how that submarine is actually passing information. The last stage requires converting from a general rule of thumb to a fixed formula. In the heuristic stage, a military officer might say information flow on a nuclear submarine must be improved but when traversing through the algorithm stage, that heuristic should become something more tangible.

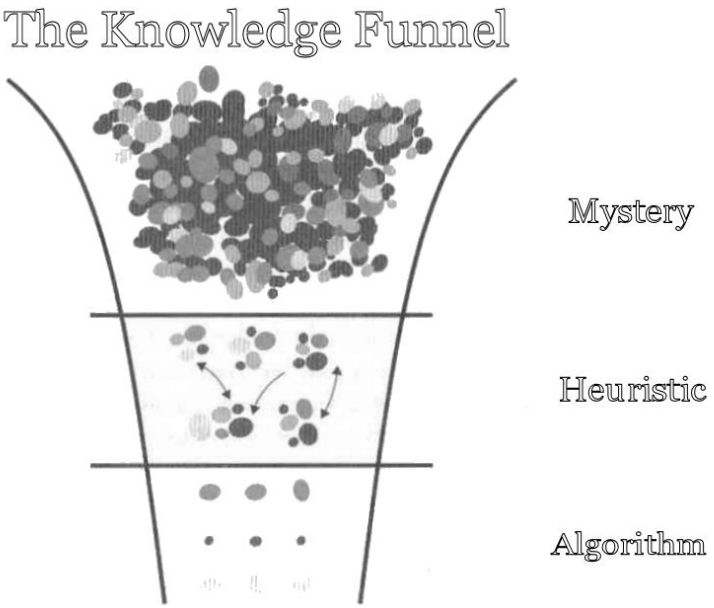

Figure 1. Roger Martin's knowledge funnel[118]

Roger Martin outlines the tools of design thinkers—observation, imagination, and configuration.[119] In his book, he explains the concepts of deep, careful, open-minded observation; honed and practiced imagination skills; and the ability to translate the idea into an activity system that will produce the desired outcome—configuration.[120] The DOD currently lacks in all three of these areas. More specifically, the Defense Department has decent observation skills but lacks in the area of *open-minded*

[118] Martin, *The Design of Business*, 8.

[119] Ibid., 160.

[120] Ibid., 161.

observation. Imagination is strong in an austere deployed environment typically because it is sparked by necessity but in a garrison setting service members are usually more constrained by standard operating procedures and regulations. And lastly, configuration is woefully below standards. At first glance, one might posit that the DOD does a good job of obtaining a desired outcome—but this is only part of configuration. The first part is translating an idea, which the Defense Department does a poor job of since most unique ideas are terminated at conception—long before they ever have a chance at prompting change.

d. Tim Brown

As an approach, design thinking draws from capacities everyone has but that are oftentimes overlooked by more conventional problem-solving practices. Brown and Wyatt explain that design thinking is best thought of as a system of overlapping spaces rather than a sequence of orderly steps—three spaces consisting of inspiration, ideation, and implementation.[121] In this system, inspiration is simply the opportunity (problem) that catalyzes the search for solutions, ideation is the process of rapidly generating and testing ideas, and implementation is the path that leads from the design thinking process to actually being incorporated as the solution to the problem.[122]

In his 2009 book, *Change by Design*: *How Design Thinking Transforms Organizations and Inspires Innovation*, Tim Brown expands on the design thinking process, explaining that the process looks like a rhythmic exchange between the divergent and convergent phases, with each subsequent iteration less broad and more detailed than the previous ones.[123] Convergent thinking is a practical way of analyzing and choosing among existing alternatives.[124] Divergent thinking, however, involves

[121] Tim Brown and Jocelyn Wyatt, "Design Thinking for Social Innovation," *Stanford Social Innovation Review* (Winter 2010).

[122] Ibid.

[123] Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation* (New York: Harper Collins, 2009), 68.

[124] Ibid., 66.

multiplying options to create choices.[125] In the divergent phase, new possibilities emerge but in the convergent phase you must eliminate options and make choices. Figure 2 shows the diverge and converge phases—this is the heart of design thinking.[126]

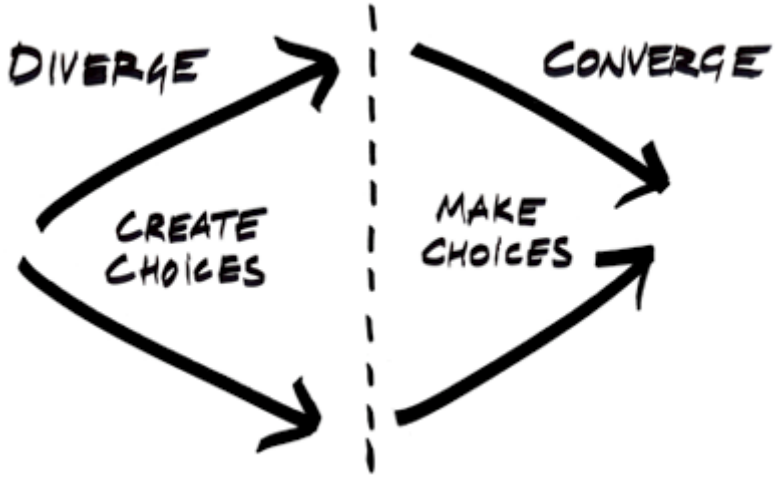

Figure 2. Convergent and divergent thinking[127]

Brown suggests that developing a culture of innovation akin to that of Google, Pixar, or IDEO is essential to fostering an environment conducive to "out of the box" type thinking.[128] Each of these companies uses the Jamming and Hanging Out paradigm outlined by Frank Barrett in his book *Yes to the Mess: Surprising Leadership Lessons from Jazz*.[129] In these informal jam sessions, jazz musicians are able to discover as a team—where they learn the common groove that will bring people together so they can learn from each other and share experiences that could potentially lead to

[125] Brown, *Change by Design*, 67.

[126] Ibid., 68.

[127] Brown, *Change by Design*, 67.

[128] Ibid., 31–36.

[129] Frank Barrett, *Yes to the Mess: Surprising Leadership Lessons from Jazz* (Boston: Harvard Business Review Press, 2012), 93–97.

breakthroughs.[130] This environment is successful specifically because of its informal, unplanned setting that encourages accidental, surprise moments of discovery and minimizes defensive routines, which Peter Senge describes as entrenched habits we use to protect ourselves from the embarrassment and threat that come with exposing our thinking.[131] This concept is not unique to the civilian sector. U.S. military service members come up with great ideas to solve problems but oftentimes these ideas are spurred either in a deployed setting or at an informal gathering of peers. It is incumbent on DOD leadership to capture the characteristics of these "solution-generating atmospheres" in order to capitalize on the outcome they produce for future competitive advantage.

3. Design Thinking Facilitators: IDEO

Herbert Simon, Richard Boland, Roger Martin, and Tim Brown have contributed immensely to the incorporation of design and design thinking into business. Without an advisory agent on the actual techniques required to bring design to business, however, their collective theory will only go so far as the reader is willing to read the theory and enact it on their own. Some companies, though, have developed their entire existence around the concepts developed by these foundational authors. IDEO (pronounced eye-dee-ohh), headquartered in Silicon Valley, is widely regarded as the foremost design thinking firm in the world. Capitalizing on their unique corporate culture and the creative talents of their academically diverse workforce, IDEO specializes in assisting organizations, both public and private, to innovate their products and improve their organizational cultures. Implementing design thinking concepts under the tutelage of David Kelley, company founder and tenured Stanford professor, IDEO has helped innovate or redesign many of the most common products in modern life, such as the toothbrush, the athletic shoe, and most famously, the shopping cart.[132]

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[130] Barrett, *Yes to the Mess*, 103.

[131] Peter Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization* (New York: Currency Doubleday, 1990), 232–233.

[132] IDEO, "*About IDEO,*" May 24, 2013, http://www.ideo.com/about/ (accessed March 10, 2014).

Tim Brown, current chief executive officer (CEO) of IDEO, offers the following insight: "design thinking is a human-centered approach to innovation…to integrate the needs of people, the possibilities of technology, and the requirements" of the customer.[133] In concert with this guiding principle, IDEO offers a six-step process that guides innovators through a three-phased conceptual approach. The six steps are:

1. Define the challenge
2. Observe people
3. Form insights
4. Frame opportunities
5. Brainstorm ideas
6. Try experiments[134]

By executing these six specific steps, the design thinker is led through the three larger, more generalized conceptual areas of "Inspire, Ideate, and Implement"—the backbone of the IDEO process. Critical to the execution of design thinking is a culture that encourages open discussion and removal of hierarchy in order to foster an environment of psychological safety, thereby enabling idea growth. To set this environment, IDEO has seven rules that govern interaction during the design process:

1. Defer judgment
2. Encourage new ideas
3. Build on the ideas of others
4. Stay focused on the topic
5. Be visual
6. One conversation at a time
7. Go for quantity[135]

Those who are schooled in the traditional methods of brainstorming or requirements-based design may find the above process antithetical to established practice.

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[133] IDEO, "*About IDEO.*"

[134] IDEO, "Design Thinking Workshop at Naval Postgraduate School," Monterey, CA, May 10, 2013.

[135] IDEO, "Design Thinking Workshop at Naval Postgraduate School."

This is precisely IDEO's challenge when working with outside entities: breaking the accepted wisdom of the current organizational culture to breathe new life, new ideas, and new creative energy into products or procedures that are often mundane, uninteresting, or proven effective through time. To shatter accepted routines, IDEO innovators harness the creative potential inherent in design thinking.[136]

To temper the possibility of unbridled creativity resulting in solutions that do not actually meet the needs of the customer or consumer, IDEO requires a mandate to shepherd the design process. In other words, they require a specific problem question that guides the iterative design process, allowing innovators to continually build upon and refine their ideas to ensure that they are 1) desirable, 2) viable, and 3) feasible. The area of overlap defined by these three concepts represents the "innovative space." A solution that is not in keeping with these three principles is not accepted. In this manner, IDEO provides a creative space where thinkers may innovate while remaining simultaneously bound by the limits of reality.[137]

4. Conclusion

While change management provides techniques for increasing the chance of success when instituting organizational change, design thinking provides an effective method to actually figure out what the change should be. While the 20th century was focused on optimization efforts to create competitive advantage, those efforts can only be effective until you are near optimization—once you reach that point, you can no longer rely on that technique to create a business edge. Instead, organizations must focus on the creation of elegant, refined products and services that connect with a customer need in a new way. In the future, both the corporate sector and the DOD will need to use techniques such as design thinking to spark creativity and innovation in order to stay ahead of their competitors. To do this, an external consultancy agent such as IDEO may be needed to facilitate utilization of the design thinking process.

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[136] Ibid.

[137] IDEO, "*About IDEO.*"

F. LITERATURE REVIEW CONCLUSION

Based on the literature review, there is a strong link between the events of the Executive TANG Forum and the fields of organizational change management, design, and design thinking. Lessons extracted from this case are generalizable to other organizations. The literature review and the case research have demonstrated the potential of utilizing the principles of design thinking to catalyze technological innovation in the submarine community with further application to the greater DOD.

As a large, complex organization with intricate dynamics, it is of great worth to DOD personnel and leaders to understand the conceptual theory of organizational change and design thinking. It is equally critical to consider the practical application of theory to achieve full understanding of its depth and context. The case presented in the following chapter is an example of efforts to apply these theories in a real-world setting. Through an analysis of the case presented, the reader will have an opportunity to consider the dynamic interaction of design and design thinking as they relate to an organization undertaking efforts to fundamentally alter time-tested methods and accepted cultural norms.

III. THE EXECUTIVE TACTICAL ADVANCEMENTS FOR THE NEXT GENERATION (TANG) CASE STUDY

A. A DAY IN THE LIFE OF A SUBMARINE COMMANDING OFFICER

> The change of command ceremony is a time honored tradition which formally restates to the officers and personnel of the command the continuity of command. It is a formal ritual conducted before the assembled company of the command. The change of command of a naval unit activity is nearly unique in the world today; it is a *transfer of total responsibility, authority and accountability* from one individual to another.[138]

Military command is reserved for the best and brightest officers the military has to offer. In the United States Navy, taking charge of a unit as a Commander (O-5) requires passing a rigorous command screening process that determines whether an officer has what it takes to command a unit filled with the nation's most critical asset —America's youth. An O-5 level command screening board typically consists of 15–20 Captains (CAPTs) and is chaired by an Admiral (usually a 1-star Rear Admiral).[139] During these extensive screening boards, every aspect of a candidate's documented performance is reviewed. While past performance is the primary metric used to determine a candidate's potential to command, those in the service and outside alike frequently wonder, what does it really take to command a naval submarine?

1. The Road to Command

Prior to screening for a command job, naval submarine officers must pass through a series of gates and do well before being considered. Submarine officers begin their career as Ensigns (O-1s) and attend Nuclear Power School and Nuclear Prototype School, each 6 months in duration. After attending these schools, where attrition can be a frequent occurrence, the junior officer (JO) then attends Submarine Basic Course for 3 months before boarding his first submarine for his "JO tour," which will last approximately

[138] United States Navy, "USS Shark Change of Command," February 1990, http://navsource.org/archives/08/pdf/0859100.pdf (accessed March 10, 2014).

[139] Glen Niederhauser, interview by Robert Featherstone, November 21, 2013.

36 months. During this initial tour, the JO is required to pass his Submarine Personnel Qualification Standards (PQS) in order to become a *qualified* submarine officer. This PQS can take up to the entire JO tour to obtain, depending on ship tasking, though that is rare and usually takes approximately 18 months.[140]

After completion of a successful JO tour, the submarine officer is typically a Lieutenant (O-3) and will then likely go on a shore tour of some variety for a period of 24–30 months. This shore tour, named in this fashion due to the non-deploying nature of the jobs in this category, can range from being a student at Naval Postgraduate School or teaching at the United States Naval Academy to recruiting duty or possibly even joint duty with another service. After completion of this first shore tour, the submarine Lieutenant will attend department head school for a period of 6 months, after which he will return to sea duty on board a submarine to serve as an actual department head (DH) for a period of 36 months. As a DH, the now relatively senior Lieutenant is given his first opportunity to be responsible for the training and administration of a large department—typically 20 to 30 officers and sailors.[141] During their DH tour, Lieutenants begin to develop the multi-tasking and administrative skills that will be required when they become senior officers. From personnel concerns to proper employment of tactics, the commanding officer charges his department heads with maintaining their departments in a well-trained, combat-ready posture. All the while, DHs maintain their personal tactical qualifications and stand watch on the bridge and in the control room, requiring them to constantly shift back and forth between tactical and administrative skills. Operating simultaneously in both the operational and administrative realms will come to define the remainder of their careers.

After a DH tour, another 36-month period on shore duty is typically next, followed by a tour as an executive officer (XO), where the officer serves as second in command of a submarine. In order to prepare for this milestone tour, the officer is required to attend more specialized training at the Prospective Executive Officer School,

[140] Josh Smith, email to Rob Featherstone, November 24, 2013.

[141] United States Navy, "Standard Organization and Regulation of the US Navy (SORN)," 91–92.

a curriculum that spans 3 months of in-depth training.[142] The depth of the course is equal to the monumental nature of the task ahead, for as an XO the submariner is responsible to the CO for manning, training, and equipping the entire submarine and its crew. Ultimately, the XO is accountable to the commanding officer for ensuring that the submarine and its crew are operating effectively and ready for combat, freeing the commanding officer to attend to the details of operational tasking and mission planning, such as digesting intelligence related to the crew's next mission or contemplating how he would like to proceed into a dangerous, shallow-water environment. In a typical day, the XO can expect to oversee maintenance in the reactor spaces, training of the watch sections, and scheduling of the following day's events, all while receiving, answering, and screening communications to the commanding officer from within the submarine crew as well as higher echelon command.[143] It is a daunting task that requires superior task management and the ability to parse large amounts of disparate information, the same skills the XO will need to have finely tuned and ready for action by the time he assumes command of his own submarine and crew.

After all is said and done, by the time a submarine officer screens for actual command, he will have anywhere from 8 to 11 years of total operational experience aboard a submarine and a total of 16 to 17 years of total time in service. With formal schools and subsequent performance tests, along with years of underway time in going from a newly minted submarine ensign to an XO, one might wonder why there is a need for such meticulous screening to get through the next gate and become an actual submarine commanding officer.

According to CAPT (ret.) Glen Niederhauser, former commanding officer of the Nuclear Attack Submarine USS *San Francisco* (SSN-711) as well as the Navy's Submarine Commanders Course,

> Being in command of a submarine is an *absolute* job. You are *completely responsible* and *totally accountable*. There is no sharing of the responsibility with anyone. If anything goes wrong, you're going to be the

[142] Josh Smith, email to Rob Featherstone, November 24, 2013.

[143] United States Navy, "Standard Organization and Regulation of the US Navy (SORN)," 38–40.

> guy that gets fired. You're held accountable for the performance of your men. A lot of people have their fingers in your business and you have to make independent decisions day-to-day but you have to pay attention to a lot of issues at the same time. A good CO can prioritize across the time horizon. You have to make sure that your ship is always ready to do whatever mission you're asked to do.[144]

After passing the rigorous command screening process, the future commander would then be slated by the Bureau of Naval Personnel to the specific submarine that he will command. Before actually taking command though, this officer is required to attend Naval Reactors School once again. For a period of approximately 3 months, the future CO gets brought back up to speed on the operation of the submarine's most critical asset—the nuclear reactor.[145] Instead of the more general nuclear reactor information that is taught to newly minted ensigns, however, he learns the complete operation of the specific nuclear reactor housed on the submarine that he will actually command. The course encompasses design, operation, and radiological controls of the reactor as well as the qualifications of the actual operators that will run it. Additionally, the Naval Reactors School addresses how to handle questions or inquiries from the press—a critical skill for the commander of a warship that completes covert, strategic-level missions and possesses an underwater nuclear power facility.[146] In addition to the Naval Reactor School, the future CO must also pass the Submarine Commander Course, a 3-month course designed to hone the *tactical* skills of the future commander. The specific focus of this course is on tactical ship driving, preparing the students to maneuver the submarine safely and accomplish assigned missions. During the commander course, the prospective CO will learn to move the ship into position and perform various mission sets that would include anti-submarine warfare, covert surveillance, attack on a surface ship, mine warfare, and a Tomahawk missile strike along with various classified missions.[147] Factoring in travel time as well as time between schools, the whole CO training pipeline is about 6 months

[144] Glen Niederhauser, interview by Robert Featherstone, November 21, 2013.

[145] Ibid.

[146] Scott Tupper, interview by Robert Featherstone, January 30, 2014.

[147] Ibid.

in duration and both the reactor course and the tactical course can be failed, which would prohibit the candidate from actually taking command.[148]

2. Burden and Isolation

> By the time an officer is assigned to command his own submarine, he has had years of experience at sea, in shore duty assignments, and in the classroom. The young men who serve at sea under his leadership should feel confident that he's the man to lead them into battle or on a safe and successful peacetime mission. The Captain of the submarine, with his "unmatched burden of isolation," is the individual to whom all look for guidance. The Captain sets the tone and everything flows from his example and leadership style—he's the man.[149]

As the Skipper of a submarine, you are the most experienced officer on board the ship and therefore are expected to *personally* make critical decisions throughout the day while the submarine is underway.[150] Because of this fact, the Navy designed the physical layout of the submarine to facilitate *centralized decision making*. For example, the CO's stateroom, where the commander sleeps, is located only a few feet from the control room where the key functions of the ship are exercised.[151]

As one could imagine, being in command of a submarine is a hectic job. One retired submarine commander remarked, "Even when you're free, you're busy. As the CO, there are *always* issues coming up—everything from training and personnel to maintenance and logistics."[152] On the other hand, being a CO can also be a lonely job. As the CO, you have no peers onboard the submarine. The chief of the boat (COB) is typically in your age group but represents the enlisted ranks and therefore the relationship with the COB must remain strictly professional. The second most senior officer, the XO, is usually 5 years younger than the CO, the department heads are usually a few years

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[148] Glen Niederhauser, interview by Robert Featherstone, November 21, 2013.

[149] Robert Genat and Robin Genat, *Modern U.S. Navy Submarines* (Osceola, WI: MBI Publishing Company, 1997), 75.

[150] Glen Niederhauser, interview by Robert Featherstone, November 21, 2013.

[151] Ibid.

[152] Ibid.

younger than the XO, and the junior officers are usually in their early twenties.[153] An example of a typical submarine *command structure* can be found in Figure 3.

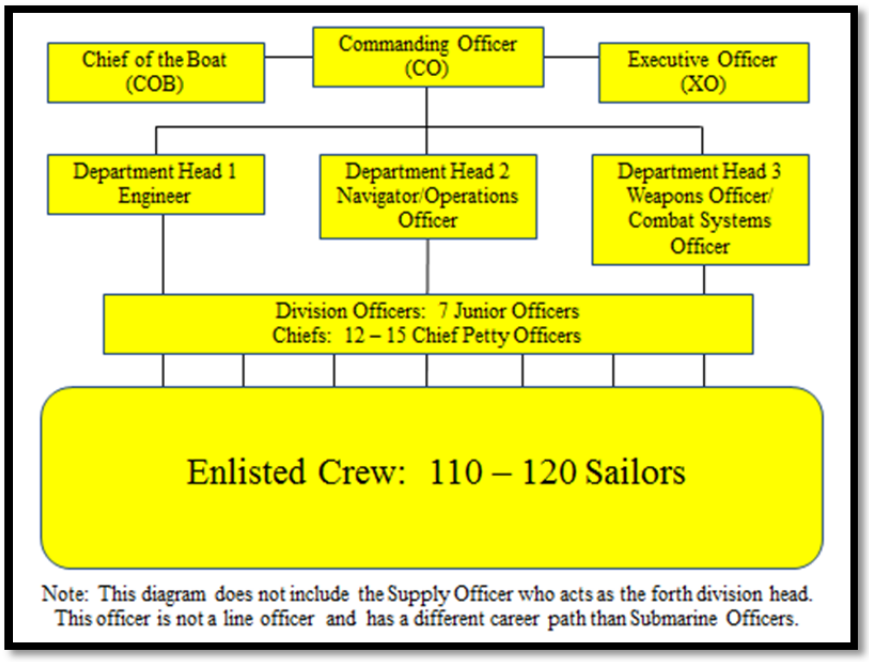

Figure 3. Command structure onboard a typical submarine[154]

While the hierarchy above helps with *administration and management* of the submarine's crew and equipment, the CO is still the individual that is solely responsible for everything his unit does or fails to do. On any given day, he can be found prioritizing the purchase of repair parts for critical systems onboard, making decisions about navigation and weapon system qualifications, leading the preparation for a naval reactor examination, ensuring training is going on while underway, and actually leading the completion of real-world tactical missions.[155] A CO must be able to synthesize a slew of inputs and make decisions across a broad range of sub-specialties.[156] According to CAPT (ret.) Glen Niederhauser, "A CO that can only do one thing at a time will not succeed. If

[153] Glen Niederhauser, interview by Robert Featherstone, November 21, 2013.

[154] Ibid.

[155] Ibid.

[156] Glen Niederhauser, interview by Robert Featherstone, November 21, 2013.

he's doing maintenance in port and not thinking about tactical training required for getting underway, he'll fall behind. And on top of everything, he's dealing with a slew of personnel problems."[157]

The constant information pull from higher commands can also be a source of stress for the CO. While active top-down management has long been a part of submarine culture, it has only been exacerbated by technology.[158] According to Andy Leal, a retired career submarine officer, "Before e-mail, a submarine left for 3 months on a deployment and the commander's boss had to *trust* that it was going to do good things. Now shortly after leaving port, the CO has probably already received multiple e-mails from the Commodore."[159] In addition to dealing with information pull from higher echelons and a slew of administration and management issues, possibly the most potentially lethal job of the CO is managing his awareness of all the surface and sub-surface vessels (contacts) near his submarine. A lapse in attention or situational awareness with respect to what else is operating near the submarine could spell disaster for both ship and crew.

3. The Control Room and Bridge

On a submarine, a "contact" is anything that could potentially cause harm to the submarine. This could be a fishing net, an underwater sea mount, an enemy submarine, a commercial merchant ship, or literally anything that could cause damage to the submarine. As a result, managing the contact picture is a top priority for the CO of any underway submarine. To assist him with this, he has a qualified officer-of-the-deck (OOD). The OOD, typically a Lieutenant, is responsible for overseeing command and control. In this capacity, he reports directly to the CO for safe navigation and general operation of the ship. The OOD typically stands watch in the control room, where the ship is driven from while submerged or at periscope depth. It is the focal point for tactical

[157] Ibid.

[158] Andy Leal, interview by Robert Featherstone, September 10, 2013.

[159] Ibid.

information. Approximately 12 to 15 personnel stand watch directly supporting the OOD. The major watch sections and watch standers include:[160]

- Ship's Control Party
  - Diving Officer of the Watch–Responsible for maintaining whatever the ordered depth is for the submarine.
  - Helmsman–Controls the ship's movement along the horizontal plane (left and right) (Figure 4).
  - Planesman–Controls the ship's movement along the vertical plane (up and down) (Figure 4).
  - Chief of the Watch–Moves variable ballast on and off the ship to maintain or adjust depth. Also, adjusts variable ballast between forward and aft tanks to maintain even keel. He also takes reports from other forward watch standers throughout the submarine (including machinery room watch, torpedo room watch, and roving watch standers). He is the hub of all the forward watch standers.

Figure 4. The Helmsman and Planesman aboard the USS *Toledo* (SSN-769)[161]

[160] While the specific number and type of personnel standing watch in or near the control room varies according to specific type and class of submarine, this list is an *example* of what the composition of the watch could look like.

[161] Free Republic, "S. Korea: U.S. Nuclear Submarine Docks in Busan," February 2008, http://www.freerepublic.com/focus/f-news/1977051/posts (accessed March 10, 2014).

- Aft Watch
  - Quartermaster–The navigation guy. He plots the ships' position, projects ship's future position, and makes sure the submarine is remaining in its assigned waters and where the Captain says he wants the ship to be.
- Tactical Watch Standers
  - Sonar Watch Standers–four or five on watch at any one time separated usually by a curtain or a door (except for *Virginia* class submarines where they are in the control room). They look at sonar screens and make reports on new contacts that are gained or lost (Figure 5).

Figure 5. Sonar operators aboard the USS *Toledo*[162]

- Combat Systems Operators
  - Fire Control Technicians of the Watch–two of them. Take sonar information and information from other sensors (visual, radar, electronic support measures), fuse it all together, and make a target track that contains bearing, range, course, speed, and closest point of approach to the submarine–for every contact.

[162] Jonesblog, "USS Toledo SSN-769," June 2010, http://prometheus.med.utah.edu/~bwjones/2009/05/uss-toledo-ssn-769/ (accessed March 10, 2014).

- Contact Manager/Contact Coordinator: Takes all information contributed by the Combat Systems Operators and reports to the OOD. He interprets all this information, reports to OOD in a streamlined fashion, and makes recommendations on how to drive the ship.[163]

In addition to the above watch standers, when the submarine is at periscope depth or surface depth the following additional watch standers report to the OOD:

- Electronic System Operator–Reports any contacts that are being made by radar systems. Physically separated from control room.
- Radio Man of the Watch–Controls all communications circuits. Physically separated from control room.[164]

When submerged or at periscope depth, the OOD stands watch in the control room. When the submarine *surfaces*, however, the OOD relocates himself to the *bridge* where he can physically see the environment around the submarine. A lookout will accompany him to the bridge to assist in visually identifying any objects that could cause harm to the submarine on the surface. When on the bridge, the OOD is physically disconnected from control room—his only means of communication is via an audio circuit (voice only)—a hand-held microphone and loudspeaker on each end along with a basic sound-powered phone handset.[165] Figure 6 shows a typical bridge on a nuclear submarine.

[163] Scott Tupper, interview by Robert Featherstone, January 30, 2014.

[164] Ibid.

[165] Pete Scala, email to Kevin Johnston, March 2, 2014.

Figure 6. CO, OOD, and lookout on the bridge of the USS *Helena* (SSN-725)[166]

4. Reports to the Commanding Officer

The OOD, whether on the bridge or in the control room, assists the CO in maintaining situational awareness of the contact picture around the submarine as well as all critical functional areas of the ship. Per the captain's standing orders there are set situations in which he requires reports from the OOD. Usually, these standing orders include any contact inside of 16,000 yards, a second report before the contact comes within 8,000 yards, and a third report if the contact will close to within 4,000 yards of the submarine. *This is for every single contact*. He will get those reports usually one at a time.

If the CO is not physically in the control room, which he usually is not, he receives verbal contact reports via an audio circuit. The only exception to this is if he is in the wardroom or his stateroom where there are display repeaters capable of replicating

[166] United States Navy, "Commander Sub Group 7," July 2008 retrieved from http://www.ctf74.navy.mil/imagery/2008/07i.htm (accessed March 10, 2014).

information from any of the ship's control room systems. If, however, he is in the engine room overseeing maintenance activities, on the crew's mess observing training, or possibly just walking around the ship keeping up with the crew, he would only receive verbal reports. Being able to *see* the data associated with a contact report when he is *anywhere* on the submarine would be ideal, but current submarine technology only enables audio reports.[167]

To help with information digestion, contact reports from the OOD are standardized. The standard report goes back decades in the submarine community and begins with the submarine's current course, speed and depth (if submerged) and is then structured using the acronym "TD-BRAD" which stands for: Target, Designation, Bearing, Range, Angle on the bow, and bearing Drift.[168] An example of a contact report could be:

> Captain, officer-of-the-deck, I am on course 000, 12 knots, have a new Visual Contact, Designated Victor 23, Bearing 205, Range 16,000 yards, Angle on the Bow is Port 30, Contact is on the left drawing left. My intentions are to maintain course and speed.[169]

In plain language, this report is saying that the watch-section has detected another contact, which the OOD has named "Victor 23" as a way to keep track of it amongst the pool of other contacts being tracked (this pool could be anywhere from a few contacts to upwards of 50). This particular contact is 16,000 yards from the submarine at a bearing of 205 degrees with an angle on the bow of Port 30, meaning that the submarine is on the port side (left side) of the contact, 30 degrees aft (to the rear) of the bow.[170] The OOD's intentions are to continue on current heading and speed. In response to this report, the CO would have to give direction such as "Very well, maintain course and speed" or "Very well, I'm going to take a look [possibly at control room displays or through the periscope]." Before giving this direction, the CO must weigh the impact of this contact in

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[167] Scott Tupper, interview by Robert Featherstone, January 30, 2014.

[168] Ibid.

[169] Ibid.

[170] Pete Scala, email to Kevin Johnston, March 3, 2014.

relation to the other contacts currently in range of the submarine taking into account the submarine's current course, speed, depth, and mission.

Without an integrated picture that he can look at unless he is physically in the control room, his stateroom or the wardroom, the CO needs to be able to integrate all that information and keep track of all those different contact reports over time *in his head* while keeping in mind where the ship needs to travel to complete the mission. He's trying to balance the ship's planned track with these contact reports as they come in and figure out any potential problems and determine what he's going to need to do to address those problems. He also has to decide when the contact situation is so convoluted that he needs to be physically in the control room to see it—or possibly on the bridge if the submarine is surfaced. All the screens that are built in the combat systems are below decks in the control room, but to visually look at the whole tactical picture if the submarine is surfaced, he has to place himself on the bridge with the OOD and the lookout. While the periscope is in the control room, the CO can only see roughly 30 degrees at a time through the periscope field of vision. While this may seem sufficient, it would be similar to watching a baseball game through a drinking straw; one would never be able to see all players on the field at the same time—the straw would have to be physically traversed to see different players. Most submariners state that having a better visual picture below deck in the control room would be ideal.[171]

Of note, there are some situations that come up where the CO positions himself in the control room and the OOD positions himself on the bridge. When the control room watch standers log a new contact, they report that to the OOD who is on the bridge, who then provides a contact report to the CO in the control room.[172] In this situation, the report originates in the control room (where the CO happens to be physically located at the time), is then passed to the OOD on the bridge, who then passes it back to the CO (who is still physically located in the control room).

[171] Scott Tupper, interview by Robert Featherstone, January 30, 2014.

[172] Ibid.

5. Constantly Making Risk Decisions

Operations on an underway submarine are 24/7—there is no downtime when a submarine is traversing the waterways of the world conducting tactical missions. Because of this, one of the hardest aspects of being a commanding officer is managing personal time to ensure you remain well rested in order to make sound and timely decisions. To maintain situational awareness and decision-making ability even while resting, the CO has a speaker in his stateroom that is connected to the control room—this speaker remains on even when he is sleeping.[173] The XO can also help with this as he stands watch as the command duty officer, a fill in of sorts for the CO, to allow him the ability to get some rest. With a good XO, the CO is able to put some constraints on the decisions that the XO is allowed and not allowed to make which permits him to get rest when needed. Unfortunately, however, this is not always possible—sleep deprivation is common amongst commanding officers.[174]

The CO needs to be able to place himself in a position to receive input and personally make decisions when the risk is high and allow subordinates to operate with his guidance when the risk is low, permitting himself to get much-deserved rest. During a typical 60-day underway period, however, it is not uncommon for the CO to go 48 hours without any sleep—and during intense missions this may happen multiple times.[175]

In the context of risk decisions, one might ask "how does the CO determine the level of risk?" During a cruise, a submarine is generally on the surface, at periscope depth, or submerged and with each of these operating configurations comes different risk factors that contribute to the CO's risk decision. Arguably the least risk for a submarine occurs when it is *submerged*. When submerged below the surface with the ocean floor thousands of feet beneath the submarine, there is minimal risk—you're not going to run into anything on the surface, you're not going to collide with the bottom, and contacts are *minimal*. Although collision with an underwater obstacle, such as a reef or sea mount, is

[173] Glen Niederhauser, interview by Robert Featherstone, November 21, 2013.

[174] Ibid.

[175] Ibid.

possible the chances are very unlikely given the relatively low stress on sensors when submerged and the overall infrequent occurrence of these obstacles. At *periscope depth* (also referred to as communications depth because the submarine can actually communicate with the outside world), however, the risk is typically much higher than being submerged. In this scenario, the only piece of the submarine above the surface of the water is the periscope. At periscope depth, however, the submarine is close enough to the surface that fishing lines or nets can snag it and also large merchant vessels could have propeller draft that would be deep enough to possibly affect the submarines' course and depth. As mentioned earlier, while the periscope itself helps to visually see contacts, it can only see 30 degrees at a time, a greatly limiting design constraint acknowledged by most submariners.[176]

Similar to the risk at periscope depth, when the submarine is *surfaced* the risk can also be very high. In this environment, the number of contacts at any one time can easily exceed 50—and collision with any one of those contacts could be catastrophic to the submarine. Because of this, the OOD and lookout physically stand on the bridge to visually see contacts, typically accompanied by the CO. While on the bridge, they are connected to the control room solely through an audio circuit (voice only). The surfaced scenario can be especially dangerous in low visibility (either at night or due to weather). In this environment it becomes very difficult for the submarine to visually see threats—the ship's safety relies almost exclusively on radar operators using very basic radar technology to plot contacts on a rudimentary display which then have to be sighted visually by the bridge team. In this scenario, sonar capabilities are highly degraded due to the high noise level associated with operating on the surface and therefore become a lower-priority sensor compared to radar and visual sighting.[177] Being surfaced can pose especially high risk because submarines do not look very big to other ships, are designed specifically to not be detected, and cannot maneuver quickly. Merchant vessels operating in the same waters rely on basic radar technology and visual cues to detect other vessels. With only part of the relatively small submarine on the surface of the water, visual

[176] Scott Tupper, interview by Robert Featherstone, January 30, 2014.

[177] Don Noyes, interview by Robert Featherstone, February 19, 2014.

detection is very unlikely, especially at night or during bad weather. A very bad situation could be something as simple as the submarine operating on the surface and there are so many contacts that the radar and sonar operators become overwhelmed and the CO, OOD, and lookout fail to visually see a super tanker bearing down on the submarine at 18 knots. This would be a very bad day for the crew. A significant proportion of submarine collisions occur when the submarine is on the surface.[178]

When the risk is high and the CO places himself in a position to receive input and personally make a decision, whether the submarine is submerged, at periscope depth, or on the surface, the environment is stressful. A bad decision by a commander could result in collision with an obstacle, being snagged in a fisherman's lines, or even colliding with another submarine or surface ship. On September 5, 2005 the nuclear submarine USS *Philadelphia* (SSN-690) collided with a Turkish merchant ship, the Yaso Aysen, off the coast of Bahrain. The collision occurred at about 2 a.m. and was the second time the USS *Philadelphia* had been involved in a collision. The two ships were entangled by the collision and took over an hour to separate. Reports after the collision indicated that the Yaso Aysen approached the USS *Philadelphia* from the submarine's port (left) side and overrode the submarine, damaging the screw and rudder, the sailplanes, and a periscope, as well as denting the hull. The dent in *Philadelphia*'s hull required no small force and likely indicated that the Yaso Aysen did not slacken her speed prior to impact—demonstrating that the merchant vessel did not see the submarine until it actually collided.[179] A Navy investigation found that the commanding officer of the USS *Philadelphia* put the submarine in a hazardous situation. As a result, he received a letter of reprimand and was subsequently relieved of command and replaced with a new commanding officer.[180]

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[178] Scott Tupper, interview by Robert Featherstone, January 30, 2014.

[179] Military.Com, "USS Philadelphia Struck by Turkish Freighter in Persian Gulf." September 2005, http://www.military.com/NewContent/0,13190,Defensewatch_091505_Perry,00.html (accessed March 10, 2014).

[180] Free Republic, "Sub Commander Relieved of Duty Following Crash," September 2005, http://www.freerepublic.com/focus/f-news/1488929/posts (accessed March 10, 2014).

To illustrate this hectic information environment that a CO must deal with to make risk decisions, the following testimony from Commodore Vern Parks, DEVRON-12 Commander, explains what a typical day underway as the CO of a submarine might be like:

> We go out there and submerge beneath the surface of the ocean and unlike the surface guys, we're *blind*. We don't see with eyes unless we're at periscope depth. When you submerge you've got to actively seek out the information that you need to understand the contact picture around you and understand the tactical environment. And to that end, the systems that we have developed have produced an *enormous amount of information*. If you're not practiced and able to prioritize, you can quickly become overloaded with the amount of information that's being thrown at you from all different directions. The guys that progress up to CO have proven that they can handle that high bandwidth and that they can prioritize adequately to be able to get the mission done while maintaining focus on safety and security. So, there's a lot of pieces to that and your typical CO on a submarine has got a constant *bombardment of information* through reports and analysis and every minute of the day he is making a risk assessment of where the ship is, what the ship is doing, what drills are running, what evolutions are running, what contacts are around, how he wants to get the mission done, and at all times he's still got to worry about security. In a typical day, try to picture yourself at periscope depth in a hostile area. Let's just say within *visual* range you have *30 contacts*. That would not be unreasonable and collision with any of those contacts could be *catastrophic*. In fact, that would be low in some places that we would be asked to conduct operations. And you have to manage that while you're also managing the rest of the entire ship, as well as responsibility for the nuclear reactor that's powering your vessel.[181]

6. Keeping Up with the Crew

> The tough days are when things don't go as planned. One of my most challenging days from a leadership standpoint was Thanksgiving Day. I was celebrating the holiday at home with my family and I got a phone call that one of my sailors was found unresponsive and in a coma while he was home with his family. Finding out that any member of the crew is hurt is very hard to deal with—as the CO *my crew feels like my family*, these guys feel like my own kids. Add that responsibility to having to manage all the sections on the boat while the requirements levied on the boat typically far

[181] Commodore Vern Parks, interview by Kevin Johnston, October 10, 2013.

> exceed the capability, you have 26 hours of work to do in 24 hours, you have to prioritize but it's tough to manage it all sometimes.[182]
>
> —Commander (CDR) Steven Mongold

In addition to the many inputs that have already been mentioned, the CO must also figure out how to understand the status of the crew in terms of physical, mental, and emotional health, which all contribute to morale. As they are the heart and soul of the submarine, the general health of the crew could ultimately determine mission success or failure. Their morale can be affected by things like rumors of a deployment extension, perceived supervisor favoritism, recent poor performance of the ship or watch section, or simply feeling homesick. As a result, keeping up with the crew is one of the most important tasks of the CO, and as it happens to be, the least standardized. On a good ship, the CO and the chief of the boat (COB) have a very good relationship—the COB manages the enlisted personnel problems and keeps the CO informed. Free flow of information between these two senior individuals, one the senior officer and the other the senior enlisted man, is critical to maintaining the health of the crew and a well-functioning organization aboard the submarine.[183]

The CO may also utilize the senior corpsman onboard to keep up with the health of the crew. Since the corpsman represents the medical expertise on the ship, he sees the sailors all day long for their medical ailments and can provide the CO with an accurate pulse of how they are doing. Additionally, the corpsman's office is typically located right on the chow line—because of this sailors will frequently drop in and talk to him. Thus, the corpsman is able to hear what the members of the crew are saying (informally) and can stay pretty well connected with the overall physical and emotional health of the crew.[184]

In addition to collecting information from the COB and corpsman, the CO also learns by simply walking around the ship. While difficult at times due to the rapid pace of operations, getting out and about helps the CO learn firsthand how the crew is doing and

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[182] Commander Steven Mongold, interview by Robert Featherstone, December 12, 2013.

[183] Glen Niederhauser, interview by Robert Featherstone, November 21, 2013.

[184] Ibid.

also relays to the sailors that he cares for their well-being. By doing this, over time a good CO develops a good sense of *feeling* how the crew is doing; according to CDR Steven Mongold, "It's kind of like a sixth sense. Observing basic interactions as crew members pass each other in the passage ways or in the chow lines gives you a good indication of how everyone is doing. With enough experience, when you board a submarine you can almost *taste the atmosphere* and feel it if you know what you're looking for."[185] Over time, a good CO also discovers the guys to stay in tune with to stay engaged with the crew—which is totally personality driven, not rank specific. Sampling across a broad spectrum, while maintaining a friendly approachable relationship is key. You have to ask them not only about what is going on with their job for the day but also about other things going on in their life and get to know them and judge their response—not only *what* they say but *how* they say it.[186]

B. SUBMARINE CULTURE

The CO of a submarine must actively lead an eclectic crew of some of the brightest and best-trained sailors in the U.S. Navy. Comprised of "7% of the Navy's people operating 25% of the Navy's combatant [ships]," the U.S. Navy Submarine Force has a rich 112-year history of service to the nation.[187] Coming of age operating small diesel-electric submarines during WWII, the submarine force converted to nuclear power in 1955 with the launch of the USS *Nautilus* (SSN-571). The famous quote of the *Nautilus*' commanding officer, "Underway on nuclear power," ushered in new strategic opportunities and a new culture centered on nuclear safety. The innovative submarine culture of WWII that resulted in countless tactical successes and legendary tales of bravery was replaced very quickly by a more *procedurally focused engineering culture* that still exists today.[188]

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[185] Commander Steven Mongold, interview by Robert Featherstone, December 12, 2013.

[186] Ibid.

[187] United States Navy, "Design for Undersea Warfare, Update One," November, 2012, http://www.public.navy.mil/subfor/hq/PDF/Undersea%20Warfare.pdf (accessed April 1, 2013).

[188] Lieutenant Commander Mark McGuirk. "Re-kindling the Killer Instinct," *Proceedings Magazine* 138, no. 6 (June 2012).

The nuclear submarine community is undeniably successful at their primary mission: waging war and conducting peacetime operations while safely operating the submarine and the reactor. Currently, the submarine force consists of 71 commissioned submarines, of which 14 are *Ohio*-class strategic-missile submarines called "SSBNs" that carry nuclear inter-continental ballistic missiles as part of the nuclear deterrence arsenal. Four are converted *Ohio*-class submarines called "SSGNs," adapted to specialize in striking land targets from the sea; they carry Tomahawk cruise missiles and special operations forces. The remainder of the submarine fleet consists of "SSN" fast attack submarines of the *Los-Angeles, Seawolf,* and *Virginia* classes, primarily used to track adversary submarines and conduct intelligence, surveillance, and reconnaissance missions.[189] More detailed information and specifications on each of the U.S. Navy submarine types and classes can be found in Appendix A.

Though missions and tactics vary widely among the different types of boats, the one constant spanning the breadth of the fleet is an "obsession with safety."[190] Some may deem this focus on safety as completely appropriate given that the crew of a submarine is responsible for operating a nuclear power plant under the surface of the ocean, even while conducting stressful and possibly lethal tactical missions. As a matter of fact, of the hundreds of nuclear submarines that have served in the fleet in the 58 years of the nuclear propulsion era, *only* two have been lost. Paul Bierly and J.C. Spender speculate that the first of those mishaps, the USS *Thresher* (SSN-593), was intentionally exacerbated by the crew in the name of safety. They posit that there was a potential for the crew to be saved had the reactor been left operational. Nuclear safety doctrine and established cultural practice, however, dictated that the reactor be shut down to prevent further disaster, dooming the crew to be lost at sea. This is illustrative of the prominence placed on nuclear safety above all else—even the lives of the crew. The uncontestable success of nuclear procedures has engendered a sort of *"cultism" around procedural compliance*.[191]

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[189] United States Navy, "Design for Undersea Warfare, Update One."

[190] Paul Bierly III and JC Spender, "Culture and High Reliability Organizations: The Case of the Nuclear Submarine," *Journal of Management* 21, no. 4 (August 1995).

[191] Ibid.

Those who are most successful in the nuclear submarine community are those that live its cultural values of safety: an intense respect for procedure and practice combined with a healthy skepticism toward practices that appear to deviate from established norms.[192]

This behavior has resulted in some observers labelling submarine culture as *risk-averse*. In the words of Lieutenant Commander Mark McGuirk, a current submarine XO and nuclear engineer, nuclear submarine culture trains its officers to "search for prefabricated answers to complex problems."[193] As he writes in *Proceedings*, McGuirk believes *established* nuclear submarine culture is currently at odds with *innovation*. Though the force adapts and changes with time and technology in order to remain on the cutting edge, it nevertheless values practices and procedures that have withstood the test of time. Because of this, large-scale shifts in procedures and processes that fundamentally alter the force are atypical. McGuirk offers that the first step in changing this is to encourage independent thinking among operators but cautions that this may not be easy: "Expect them to be confused; they have probably not been required to *innovate* during their careers to date."[194]

C. INTRODUCING NEW SUBMARINE TECHNOLOGY: THE ARCI, APB, AND TI PROCESSES

> I personally think our old requirements-based way of doing business is old and clunky…there are reasons they have to do some of that…BUT, I think we've got to have the [commercial-off-the-shelf technology] piece in play. I think if we don't, we're going to miss a lot of technology opportunity and we're going to be shooting behind the rabbit. That's what you don't want to do. We need to be in front of issues and be flexible enough to grab technology now.[195]
>
> —Master Chief Petty Officer of the Navy (MCPON, ret.) Rick West

To meet the pressing need to continually update submarine technology, there are numerous processes that feed updated technology to the fleet, some focused on nuclear

[192] McGuirk. "Re-kindling the Killer Instinct."

[193] McGuirk, "Re-kindling the Killer Instinct."

[194] Ibid.

[195] Master Chief Petty Officer of the Navy (ret.) Rick West, interview by Kevin Johnston, January 11, 2014.

propulsion and some on weapons technology, while others handle damage control and other areas of the submarine. Each of these technology update and acquisition functions is managed by a program office within the Navy Sea Systems Command (NAVSEA). NAVSEA is responsible for designing, building, and maintaining the Navy's fleet of ships and submarines. They partner with private contractors, university labs, other government agencies, and Navy research and development facilities to provide continual upgrades and improvements to the full spectrum of submarine technology.[196]

One of those NAVSEA offices, the Undersea Systems Program Office (IWS 5), is part of Program Executive Office Integrated Warfare Systems (PEO IWS), and is responsible for developing new submarine tactical system technology. Within IWS 5, IWS 5A works in concert with the Submarine Acoustics Program Office (PMS 401) of PEO Submarines on the Acoustic Rapid COTS Insertion (ARCI) program. ARCI is designed to leverage rapid insertion of commercial technology to achieve processing advances and manage obsolescence while continually improving submarine sonar. IWS 5A's role is to rapidly develop, test and implement software applications to run on the tactical systems.[197] This groundbreaking approach to technology insertion was developed in response to significant challenges in the acoustic detection abilities of the submarine fleet during the mid-1990s. ARCI broke the mold of traditional requirements-based acquisitions by harnessing the availability of relatively inexpensive commercial processing technology to rapidly enhance acoustic and sonar capability.[198]

Technology developed through the ARCI process is introduced to the fleet via two separate yet highly inter-dependent processes: Advanced Processing Build (APB) and Technology Insertion (TI). APB delivers software-only upgrades to the fleet each *odd-numbered year*; for example, there were APBs delivered in 2011 and 2013. Where APB handles software, TI deals with the hardware and the associated software to support the new TI. TIs are conducted each *even-numbered year*, 2014, 2016, etc. Through the

[196] Captain Jim Stevens, "The How and Why of Open Architecture," *Undersea Warfare* (Spring 2008), http://www.navy.mil/navydata/cno/n87/usw/spring08/HowAndWhy.html (accessed October 2, 2013).

[197] Pete Scala, email to Kevin Johnston, March 2, 2014.

[198] Stevens, "The How and Why of Open Architecture."

interaction of the APB and TI processes, U.S. submarines are given an acoustic upgrade each year with technology primarily sourced from commercial industry. Not without its initial critics or occasional stumbles along the way, ARCI is successful in providing the fleet with continual system enhancement. As a testament to the success of the program and the benefit of open architecture in promoting flexible acquisition strategies, the Chief of Naval Operations authored a memo citing ARCI as the example to emulate when instituting open architecture in the fleet.[199] Figure 7 gives a graphic representation of the ARCI business model.

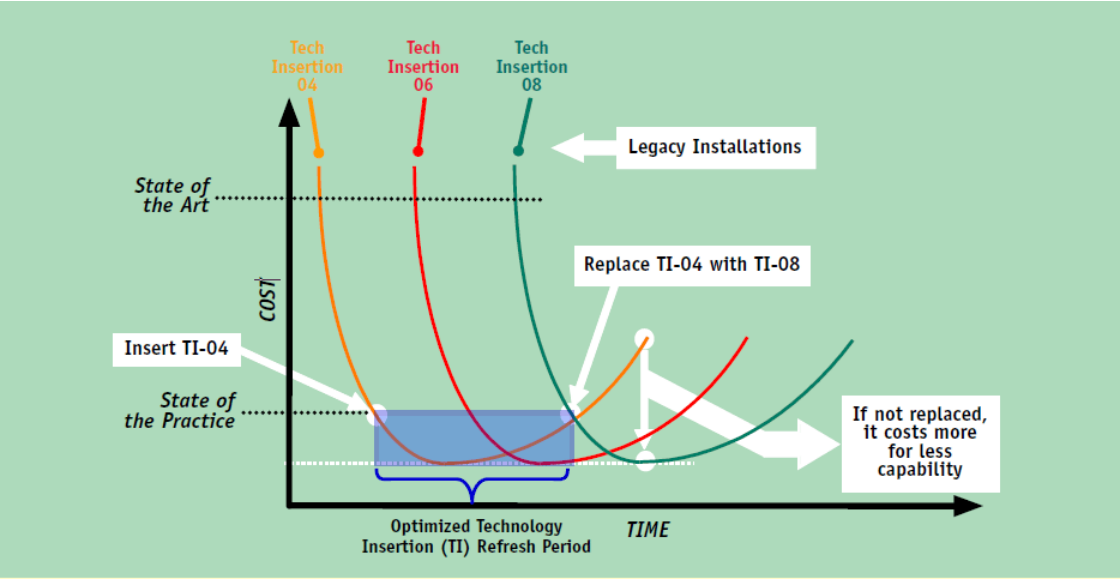

Figure 7. The ARCI business model[200]

In order to know what must be produced in upcoming APBs and TIs, IWS 5A relies upon fleet (customer) input collected via input from the Submarine Tactical Requirements Group (STRG). Every other year, the STRG identifies and prioritizes those tactical capabilities they believe are important for the next APB build. This list is provided to the Director Submarine Warfare Division (OPNAV N97) via the Type Commander, Commander Submarine Force. OPNAV N97, in turn, develops a

[199] Admiral M. G. Mullen, Memorandum Regarding Navy Open Architecture, August 28, 2006.

[200] Stevens, "The How and Why of Open Architecture."

requirements document directing IWS 5A to develop the requests of the STRG. In the words of the Commander, Submarine Development Squadron TWELVE and current Chairman of the group, Commodore Vern Parks, "Big picture, the Submarine Tactical Requirements Group is the *fleet voice* to the requirements folks in the submarine force as it was envisioned, and up until even today the fleet voice for articulating the capabilities—the capabilities that we, the fleet, would like to see in our tactical systems."[201]

Input from the fleet is critical to the ARCI process as without it, engineers and developers would be without guidance as to what actually needs to be addressed. Lacking this input, developers would simply be guessing as to where to direct their efforts. Even with input from the STRG, however, developers working on behalf of IWS 5A were still left to develop to the dry requirements and metrics contained within the annual requirements memos. Though the products fielded in each APB and TI were certainly capable, there was a sense by some that they lacked operator-centric context, especially as the generation of operators using the technology changed over the years. Developers who were accustomed to designing systems to be used by operators who did not grow up as technically-literate and comfortable with advanced technology began to receive feedback that the technology aboard submarines was not resonating with today's digitally-native users.[202] Sure, users could be trained to use the systems as designed but to some community insiders that missed the point: systems can and should be designed to be as intuitive as possible to promote ease of adoption and overall user efficacy.[203] An example relayed by LCDR Thomas Hall in his previous research on innovation in the submarine fleet illustrates this well:

> Lieutenant Josh Hausbach was at sea familiarizing himself with a new console and trying to figure out which button would bring up a geographic plotting (geo-plot), or mapping, of the boat and other contacts being tracked by the watch team. There was a little button at the bottom, and it's got a 'G' on it. I'm sitting there, and I'm clicking on it, and I'm like "Why

[201] Commodore Vern Parks, interview by Kevin Johnston, Monterey, CA, October 10, 2013.

[202] Gavin, "A Case Study of Managing Information Technology through Design."

[203] Josh Smith, *"Junior Officer Watch Team Innovation Conference,"* Johns Hopkins University Applied Physics Lab (June 1, 2010).

> is the geo-plot not coming up?" Cause I see a 'G,' and I think geo-plot. And finally after sitting there and pushing it for 30 or 40 times, I notice up at the top that it says 'frame grab,' and it has a date-time stamp on it. And it's right now. I click it again, and it changes. "Oh, that's the take a picture button!" So, through this process of feeding back to the APB folks, the very next software iteration Andy Leal went to the engineers, and took his phone. "Do you see this camera button on here? Turn this 'G' into the iPhone camera button." And now, if you want to take a picture…you push the camera button.[204]

This is one example among many but it serves to demonstrate the challenge of fielding system upgrades that will be well received by the fleet operators who must use these systems under real-world conditions. What makes sense to the developer in the lab often does not translate well to the fleet. In the above example, the fleet user is asking for a graphical user interface that replicates what he has grown accustomed to using over time. While he undoubtedly learned to use the "G" function through trial and error, the fact that it took 30-40 attempts represents the crux of the divide between laboratory developer and fleet user. Speaking to this conceptual gap, former MCPON West offers his thoughts:

> So many times big Navy rolls programs or things out and they miss the key link…and that is Fleet [user] buy-in and the ability to execute…You know that if you have to push more than five or six buttons, typically, you lose some of the kids these days.[205]

1. APL

Home to some of the top minds in the engineering and physical sciences, the Johns Hopkins University Applied Physics Lab (APL) was chartered in 1942 as a "not-for-profit center for engineering and research and development" to advance military technology during World War II. After the war, APL developed a unique niche as a critical bridge between government and industry. Due to their non-profit and non-competitive status, APL works in concert with top industry technology and defense firms to allow government agencies access to unbiased, non-competitive input from academic

[204] Hall, "A Case Study of Innovation and Change in the U.S. Navy Submarine Fleet."

[205] Master Chief Petty Officer of the Navy (ret.) Rick West, interview by Kevin Johnston, January 11, 2014.

and industry leaders. APL currently conducts research and development on behalf of all branches of the U.S. military and the National Aeronautics and Space Administration (NASA).[206]

With sponsorship from IWS 5A, APL leads the Operator/Machine Interface Working Group (OMIWG). This group is tasked with enhancing the display and interface systems that allow operators to interact with mission systems aboard the submarine. In doing so, they look to enhance and improve the user-friendliness, intuitive operation, and ability to quickly ascertain information displayed to operators. Their products are designed for inclusion in future ARCI APBs and TIs.[207] In this role, APL and the OMIWG is one of several organizations that IWS 5A relies on to carry out the multi-organization peer review process that proposed APB technology undergoes.

Taking input from fleet users, the OMIWG works directly with private industry counterparts to introduce new technology concepts into the ARCI process. Through interaction with fleet users, industry, and IWS 5A, the OMIWG provides a critical communications bridge—permitting two-way communication between APB process stakeholders.[208]

Injecting fleet input directly into the development process would go far in closing the gap between developer and user. Gaining such input, however, will require creativity and *leaders in the right places* willing to break with the ways of the past and try something a bit out of the ordinary.

D. THE CATALYST FOR CHANGE

In 2010, Naval Submarine Forces received a new commander, a visionary by the name of Vice Admiral (VADM) John Richardson. Prior to serving as Commander of Naval Submarine Forces, Richardson served as Commodore of Submarine Development Squadron 12; Commander, Submarine Group 8; Commander, Submarine Allied Naval

[206] The Johns Hopkins University Applied Physics Lab, "About APL," 2013, https://www.jhuapl.edu/aboutapl/default.asp (accessed November 4, 2013).

[207] Josh Smith, interview by Robert Featherstone, October 25, 2013.

[208] Joshua D. Smith, remarks on Tactical Advancements for the Next Generation, August 2013.

Forces South; Deputy Commander, U.S. 6th Fleet; Chief of Staff, U.S. Naval Forces Europe and U.S. Naval Forces Africa.[209] As the Commander of Submarine Development Group 12 (DEVRON-12), he was responsible for supporting the Navy's vision of the future by developing and evaluating submarine tactics and disseminating those tactics to the operating forces.[210] As mentioned earlier, the Commander of DEVRON-12 also serves as the chairman, Submarine Tactical Requirements Group (STRG), which is charged with providing operational insight by identifying and consolidating fleet tactical needs and prioritizing them for software developers.[211] In 2006, VADM Richardson articulated his view of the major challenge facing the Naval Submarine Community: the expansion of sensors to cover the breadth of the electromagnetic and acoustic spectra, and the addition of off-board sensors, has led to an *avalanche of information* on the watch team.[212] Richardson viewed improved information management, including the use of *intuitive* interfaces, as a means to begin addressing this predicament.

In April of 2010, a former submarine junior officer by the name of Josh Smith drafted a white paper intended to promote a different way of approaching innovation within the submarine community. Titled the "Junior Officer Watch Team Innovation Conference," Smith envisioned a symposium of sorts that would harness the open-mindedness and creativity of more junior officers and sailors in the fleet.[213] He argued that the current up-and-coming submariners were used to interacting with iPhones, Facebook, Twitter, SMS, XBOX360, iMac, iPAD, and a laundry list of other commercial products.[214] If the Navy could combine this intuitive interaction experience with the junior submariners' recent operational experiences, these junior members of the submarine community would make ideal candidates for explaining to the development

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[209] United States Navy, "Admiral John M. Richardson Biography," http://www.navy.mil/navydata/bios/navybio.asp?bioID=440 (accessed November 4, 2012).

[210] United States Navy, "Commander, Submarine Group Two," http://www.public.navy.mil/subfor/csg2/Pages/SubmarineDevelopmentSquadronTwelve.aspx (accessed November 4, 2012).

[211] Stevens. "The How and Why of Open Architecture."

[212] Gavin, "A Case Study of Managing Information Technology through Design."

[213] Hall, "A Case Study of Innovation and Change in the U.S. Navy Submarine Fleet."

[214] Gavin, "A Case Study of Managing Information Technology through Design."

community how the submarine Navy could leverage today's technologies to become more effective.[215] In his own words:

> There needs to be a way to tap into [the] wealth of RECENT tactical experience to obtain ideas for *training, technology, task flows, system deficiencies, lessons learned,* (emphasis added) and other concepts from [the junior officers'] perspective. These officers of the deck are more influenced by commercial technology than any generation of junior officers before them.[216]

Smith introduced the idea to fellow colleagues at APL as well as Navy contacts he remained in touch with after his departure from the Navy's submarine force. The white paper was met with some skepticism though—some were all for it but others were a little more reserved, acknowledging the idea's merit but wondering how it could ever actually be put into action.[217] Without adequate traction, Josh's vision for submarine community innovation would die on the vine. Fortunately, by July 2010 IWS 5A had been briefed on the concept in Smith's paper, embraced it, and set aside funds in its budget to support the planning and execution of Smith's vision.[218]

During this time period, VADM Richardson continued to press for the application of intuitive commercial interfaces in submarine design. In a February 2011 meeting with IWS 5A and DEVRON-12, Richardson shared a recent experience in which, after about 3 hours of familiarization, he was able to use Google Earth to manage the Navy's relief effort in Haiti, and contrasted that with the 3-week training required for the Navy's Voyage Management System. At this same meeting, IWS 5A introduced Smith's idea of holding a Junior Officer Watch Team Innovation Conference. The idea was met with great enthusiasm by Commodore Bill Merz, current DEVRON-12 Commander, as well as Mr. Scott Dilisio, executive assistant to VADM Richardson. In May 2011, the idea became official when Commodore Merz from DEVRON-12 and Mr. Pete Scala from IWS 5A agreed to jointly host the event. The staffs of these two agencies immediately

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[215] Ibid.

[216] Smith, *"Junior Officer Watch Team Innovation Conference."*

[217] Josh Smith, interview by Robert Featherstone, February 8, 2014.

[218] John Stapleton, email to Robert Featherstone, March 3, 2014.

began discussions on a plan of action and milestones for hosting this revolutionary collaborative workshop.[219]

By July 2011, Commodore Merz had settled on a new name for the conference—Tactical Advancements for the Next Generation (TANG), honoring the legendary World War II U.S. submarine USS *Tang* (SS-306). Of note during the event planning, APL's director arranged a meeting with Eric Haseltine, former Walt Disney imagineer and executive, who recommended involving IDEO, a design and innovation consulting firm headquartered in Palo Alto, California, in the event.[220] Finally, in November of 2011, IWS 5A and DEVRON-12 executed this historic mission. Partnered with the Applied Physics Lab and IDEO, the Navy's submarine community set out to develop innovative solutions to existing technological inefficiencies. The TANG, envisioned by Josh Smith and put in motion by Mr. Scala and Commodore Merz, maintained the same primary mission that Smith had originally proposed–a workshop of sorts that would harness the open-mindedness and creativity of more junior officers and sailors in the fleet. In total, 27 junior officers, Sonar Technicians, and Fire Controlmen from across the Navy's submarine community were invited to San Diego, CA to participate in the first ever TANG Forum.[221] At the end of the 3-day TANG event, a few key concepts emerged:

[219] Ibid.

[220] John Stapleton, email to Robert Featherstone, March 3, 2014.

[221] Hall, "A Case Study of Innovation and Change in the U.S. Navy Submarine Fleet."

- **TANG Forum Common Object Oriented Layered Geo.** The TANG participants envisioned a single system that would layer information and provide data-rich icons with radial menus borrowed from the gaming industry (Figure 8).[222]

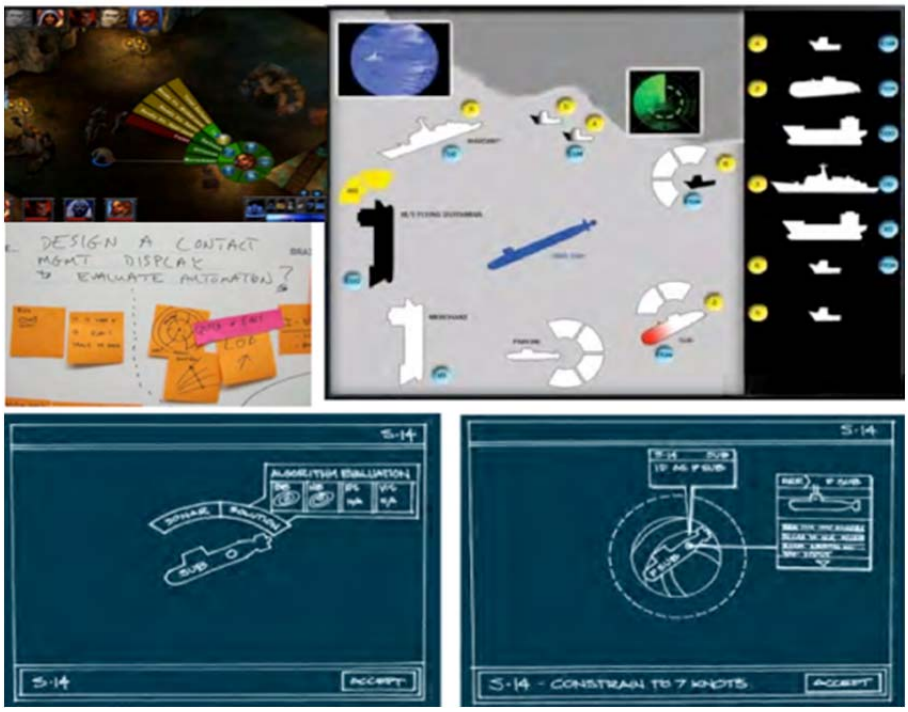

Figure 8. TANG Forum Common Object Oriented Layered Geo

[222] Gavin, "A Case Study of Managing Information Technology through Design."

- **TANG Forum Data Mobility: Go-Anywhere Tablet (GAT).** The TANG Forum's image of a Go-Anywhere Tablet would allow an operator to release himself from his work station console and allow him the freedom to move throughout the boat while maintaining continued access to information and displays (Figure 9).[223]

Figure 9. TANG Forum Data Mobility: Go-Anywhere Tablet (GAT)

[223] Gavin, "A Case Study of Managing Information Technology through Design."

- **TANG Forum Proficiency and Training Tracking System.** One of the most time-consuming functions in the military is the hours of necessary qualification training. One of the most frustrating occurrences is when a military member completes a duty cycle performing a specific job and then must report for training on the very task he had spent the past 8 hours performing. The TANG Forum developed a system that would allow them to accrue points for completing training modules or guided work flows or for successfully carrying out certain real-world missions. The operator would also achieve similar "experience points" for other qualifications throughout his career. Being able to take credit for completing different tasks on duty would immerse the operator in an environment that created a system where operators would truly "train like they fight" (Figure 10).[224]

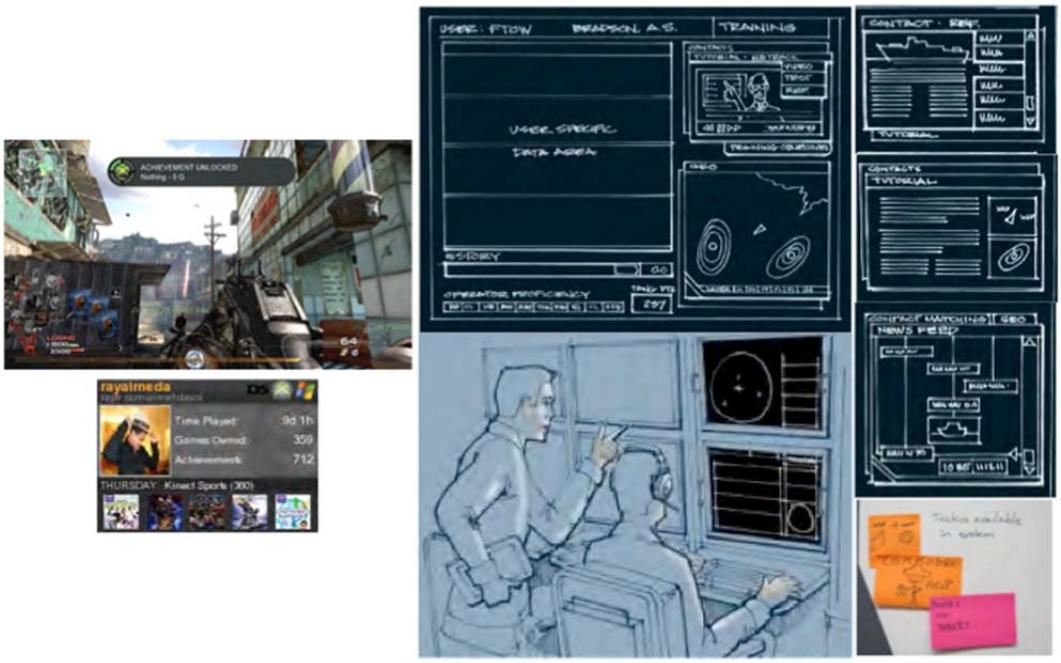

Figure 10. TANG Forum Proficiency and Training Tracking System

[224] Gavin, "A Case Study of Managing Information Technology through Design."

- **TANG Forum Predator Display:** The ideas for displays that emerged from the TANG Forum married the needs of the operator to the needs of the decision maker. In a groundbreaking discovery unearthed by the TANG Forum, the simple idea of presenting data in an intuitive radial format emerged in the Predator Display. This concept was so compelling that by January 2012 developers from IWS 5A would take the conceptual idea from its literal origins as a pizza box prototype to a physical construct running real sonar data in Step 2 testing (Figure 11).[225]

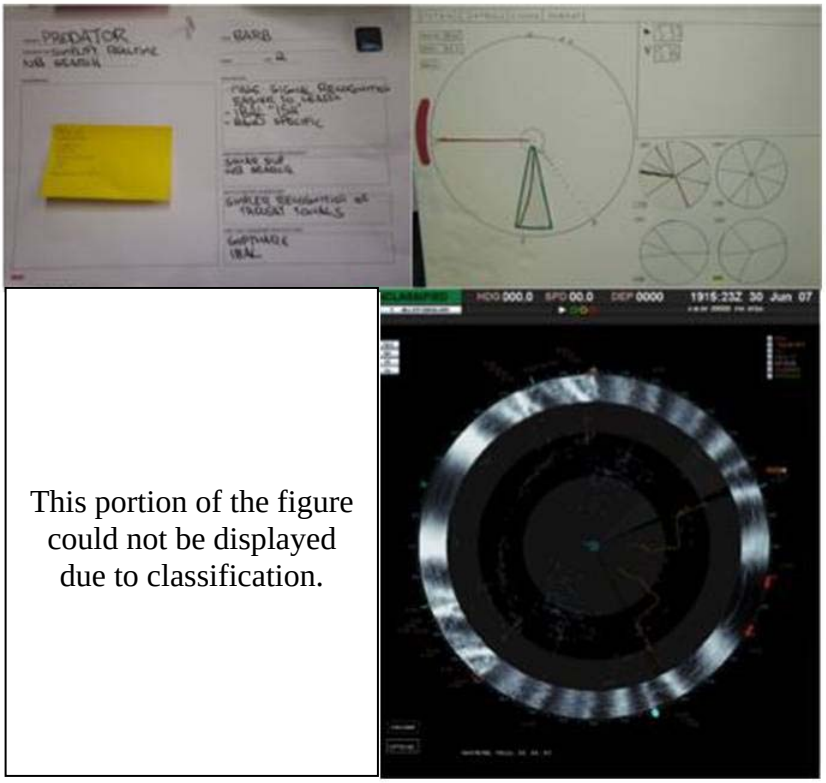

Figure 11. TANG Forum Predator Display

Thanks to the visions of VADM Richardson and Josh Smith; countless months of work done by members of DEVRON-12, IWS 5A, APL, and IDEO to actually plan and execute the event; and the open-mindedness and creativity of the participants, the first ever TANG Forum was a huge success. New innovative ideas had been derived and a new process of brainstorming utilized—and since some of these ideas transitioned from

[225] Gavin, "A Case Study of Managing Information Technology through Design."

concept to a tangible form actually progressing through the acquisition pipeline, the forum methodology was validated. Future technological improvements through the APB upgrades would include some of these TANG ideas.[226] Why stop there?

When the idea of hosting a collaborative brainstorming session was first pitched, Commodore Merz, the Commander DEVRON-12, was immediately excited about the idea but wanted to consider opening the target audience to include some command-level submariners. Josh Smith and Scott Tupper, who served as Commodore Merz's executive director for the Submarine Tactical Requirements Group, felt that inviting more senior commanding officers might inhibit creativity from the junior participants in the forum. After voicing these concerns, Commodore Merz agreed to keep the first TANG to strictly junior personnel.[227]

In November of 2011, shortly after the success of the initial TANG, Commodore Merz reminded Tupper and Smith that the sub community still needed to address the needs of the Commander.[228] Just 6 months later in May of 2012, Commodore Merz relinquished command to Commodore Parks. Shortly after taking command, Commodore Parks was briefed on the idea to conduct another TANG Forum, but this time with current and post-command submariners to address the information needs of a submarine commander. Commodore Parks, with intimate knowledge of how successful the original TANG had been and a thorough understanding of the value in having a place where submariners could come up with new ideas, jumped all over the idea of doing a TANG for mid-level submarine leadership. He understood that brainstorming with more senior officers would meet a current need in the submarine community.[229] This next event would be called the Executive TANG.[230]

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[226] Josh Smith, interview by Robert Featherstone, February 8, 2014.

[227] Scott Tupper, interview by Robert Featherstone, October 9, 2013.

[228] Ibid.

[229] Ibid.

[230] Josh Smith, interview by Robert Featherstone, August 22, 2013.

After the DEVRON-12 staffed planned the necessary details, Commodore Parks officially pitched the idea of conducting an Executive TANG to VADM Richardson via e-mail on 9 August 2012. In this e-mail, the Commodore explained:

> The inaugural TANG was of great benefit and continuing to use this process will bring a large return on the investment to the Submarine Force…Our goal will be to use the experience and vision of our serving pre-, current and post-COs with an eye toward leveraging their perspective on how to access and interact with Command-level information...we are looking to develop ways to free the commanding officer from the cognitive load associated with operator tasks and instead facilitate risk vs. gain determination, pattern recognition, managing uncertainty and keeping the CO "above the fray."[231]

In short time, Richardson agreed to conduct an Executive TANG. Just 2 weeks after pitching the idea to VADM Richardson, Commodore Parks e-mailed the staff of DEVRON-12 letting them know the Executive TANG was a go. On 7 September 2012, VADM Richardson relinquished command Naval Submarine Forces to VADM Connor.[232] After the Naval Submarine Forces command turnover, Richardson was to be promoted to 4-star Admiral and take command as Director, Naval Nuclear Propulsion.[233] VADM Connor would now oversee the execution of the Executive TANG. Shortly following the Change of Command, letters went out to all squadron Commodores and group commanders from VADM Connor soliciting nominees.[234] Unfortunately, due to sequestration delays, a notice to postpone the Executive TANG went out in February of 2013.

On 21 June 2013, after sequestration delays had been worked out, Commodore Parks e-mailed VADM Connor proposing the idea to conduct the Executive TANG in September at Naval Station Pearl Harbor, Hawaii. VADM Connor concurred immediately.[235]

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[231] Commodore Vern Parks, e-mail message to Vice Admiral John Richardson, August 9, 2012.

[232] United States Navy, "Connor Assumes Command of Submarine Force," http://www.public.navy.mil/subfor/csg2/Pages/CSLCoC.aspx (accessed November 4, 2012).

[233] Ibid.

[234] Scott Tupper, interview by Robert Featherstone, October 9, 2013.

[235] Ibid.

On 3 July 2013, VADM Connor released a message formally soliciting support for the first-ever Executive session of the Tactical Advancements for the Next Generation. In this message, the Admiral requested each Squadron nominate one commanding officer or post-Command Deputy to DEVRON-12 to participate in the first-of-its-kind innovation event aimed at developing new tools to support the submarine commanding officer.

As the deadline for nominations neared, only five names had been submitted to the DEVRON-12 Staff. After a friendly reminder from Commodore Parks, the remaining names were submitted—in a period of 1 week, the list of nominees went from 5 to 33.[236] The Executive TANG participant roster was complete.

E. IDEO

A key component to the success of the first TANG was outside instruction on the design thinking process. IDEO, headquartered in Silicon Valley, is internationally regarded as one of the foremost design thinking firms in the world. Capitalizing on their unique corporate culture and the creative talents of their academically diverse workforce, IDEO specializes in assisting organizations, both public and private, to innovate their products and improve their organizational cultures. Implementing design thinking concepts, IDEO has helped innovate or redesign many of the most common products in modern life, such as the toothbrush, the athletic shoe, and most famously, the shopping cart.[237] Tim Brown, current CEO of IDEO, offers the following insight: "design thinking is a human-centered approach to innovation…to integrate the needs of people, the possibilities of technology, and the requirements [of the customer]."[238]

Understanding that they had a tough challenge ahead of them in terms of introducing design thinking and participative collaboration to the submarine force, Smith of APL met with IDEO to investigate the possibility of their assistance at the outset of planning for the initial TANG in 2011. Once on board with the TANG project, IDEO

[236] Scott Tupper, interview by Robert Featherstone, October 9, 2013.

[237] IDEO, *"About IDEO."*

[238] Ibid.

brought both their expertise and unique approach to design to the effort to innovate in the submarine community. From the inception of the TANG initiative, IDEO has been asked to guide embedded fleet users through the design thinking process.[239]

In order to arrive at the most innovative solutions possible, IDEO rejects the notion of traditional funnel-based idea generation where a great many ideas are reduced to a few remaining ideas via a funnel-like process of idea filtering. In the words of Dave Blakely, Executive TANG project lead at IDEO,

> Years ago, innovation was taught using the funnel model, which is now obsolete and has been rejected…I might start with 20 or 30 or 100 different ideas and I would boil those down to 10, with analysis and prototyping and testing. And then I'd boil it down to three and then sort of inexorably, the single best idea comes out the other end of the funnel, right? You're funneling down…[240]

According to Blakely, the flaw with the funnel method is the assumption that innovation is linear. Rather, he believes innovation is circuitous and does not follow a prescribed pattern or planned flow. Attempting to capture innovative efforts in a linear fashion may prove convenient for those interested in "tracking" such efforts but it is not effective at capturing the true meandering nature of design. In place of the funnel method, IDEO uses a method they refer to as *generate and refine* (the "double bubble" represented in Figure 12), which is grounded in the notion that innovation is a process of alternating divergence and convergence of both thought and action. IDEO describes their design thinking process in three brief steps:

1. Understand the users and context of the system being designed
2. Use this knowledge to generate a diversity of *potential* solutions at a low level of resolution
3. Explore the solution directions that show the greatest promise and feasibility[241]

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[239] Josh Smith, interview by Robert Featherstone, October 25, 2013.

[240] Dave Blakely, interview by Robert Featherstone, September 4, 2013.

[241] IDEO, *Executive TANG Workshop: Workshop Process Guide.* Palo Alto, 2013.

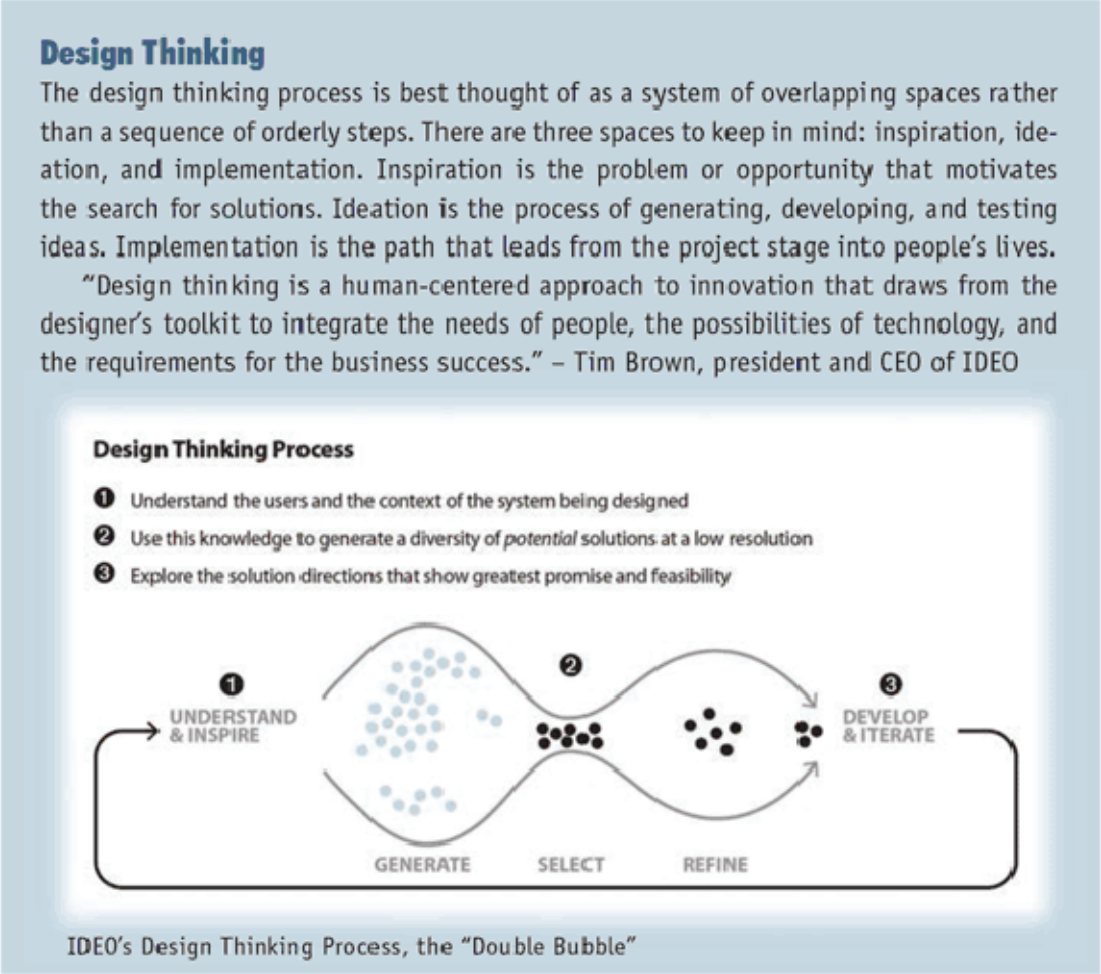

Figure 12. IDEO design thinking methodology

The IDEO process begins with a problem or challenge statement from which direction in conducting initial research is derived. IDEO believes strongly in the value of conducting deep research into the way products or systems that are being examined for redesign are currently being used. At the outset of every design effort, they conduct a process of user research consisting of user interviews and observation sessions, expert interviews from associated scientific or engineering fields, and even analogous research in which the experiences of subjects from dramatically different fields but with similar needs are examined in order to shed fresh light on the problem statement at hand. For example, in the lead up to Executive TANG, IDEO conducted interviews with emergency

room doctors to gain insight into the challenges they face, believing that those challenges were comparable to the ones faced by submarine COs.[242]

Once user cases are examined, interviews conducted and analogous situations analyzed, the next step in the process is to develop insights that can be related in brief, yet powerful statements. This process follows the diverge/converge model as well. IDEO facilitators and clients develop insights to describe the problem contained within the challenge statement. This represents the process of the first bubble—*generate*. All insights are then considered by the group and synthesized into insights that deliver the greatest meaning. This is the *refinement* process of the second bubble. By developing insights using the collaborative process and the value-additive effects of the generate and refine process, the insights that result are more powerful and relatable to the audience of participants.[243]

Once insights are synthesized and settled upon, the task is then to develop "how might we…" questions (HMWs) that address the fundamental elements of the insights. Using the same generate and refine process, potential HMWs are brainstormed, synthesized, and ultimately selected. The HMWs are critical to the presentation of the problem to participants as they frame the problem in a manner that invites creative response—they provide the point of departure for participants to begin to exercise their creative processes in direct response to the question of "how might we do something?"[244]

Once the participative design activities are under way and contributors are attempting to answer the HMWs, the generate and refine process begins anew but in a larger and more visceral context. At this point, participants are invited to brainstorm potential solutions in a highly participative and energetic manner. According to IDEO, the goals of brainstorming are: "To generate a lot of ideas in a little time; to get different perspectives; and to build excitement." In order to maximize the effectiveness of a brainstorming session, IDEO has developed "The 7 Rules of Effective Brainstorming,"

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[242] Dave Blakely, interview by Robert Featherstone, September 4, 2013.

[243] Ibid.

[244] IDEO, "Design Thinking Workshop at Naval Postgraduate School."

reflected in Figure 13. Through this process of "semi-structured" idea generation, new, creative, different, or innovative potential solutions are offered to the group for consideration during the subsequent processes of selection and refinement reflected in the second "bubble" of the process.[245]

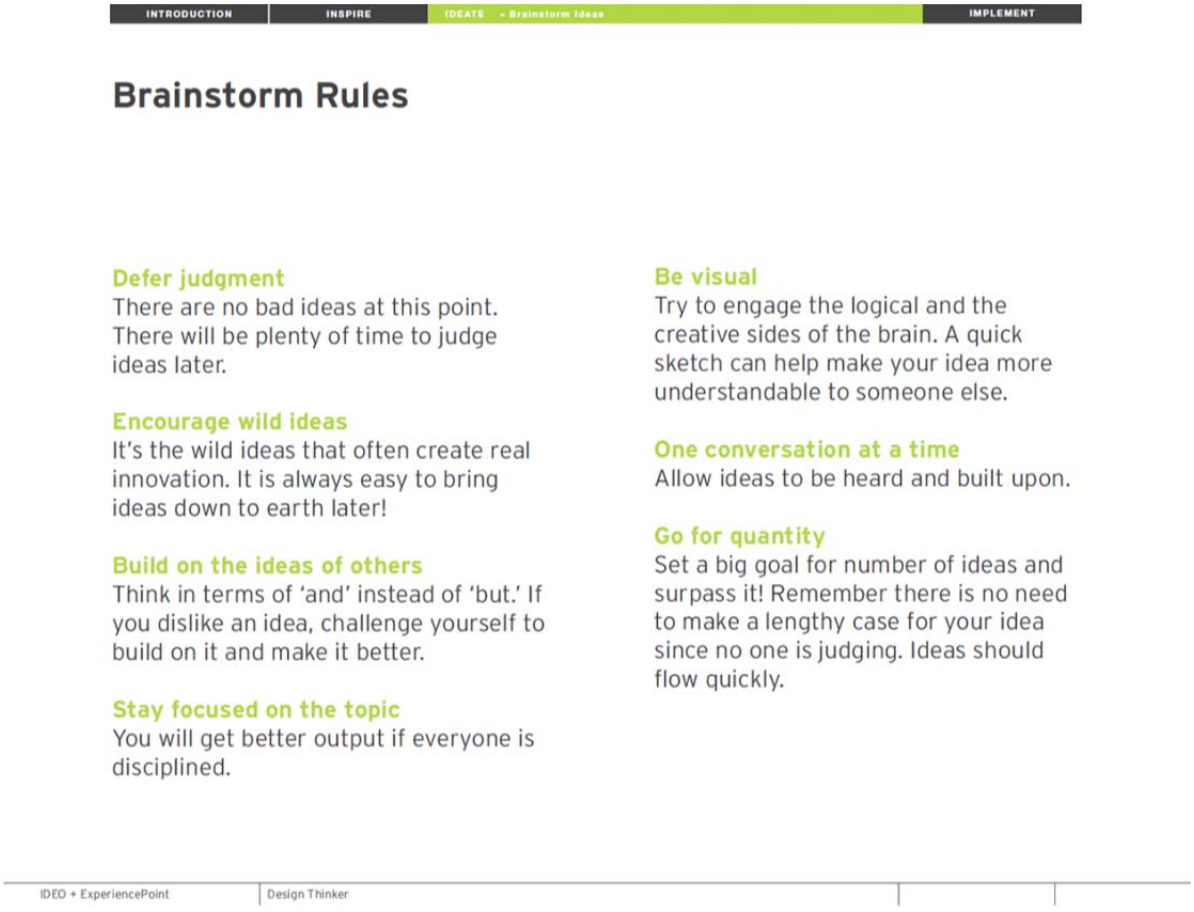

Figure 13. IDEO's 7 Rules of Effective Brainstorming[246]

Essential to the IDEO process is a focus on rapid, low-resolution prototyping to enhance further creativity and refinement. Dave Blakely remarks on the value of this step and its placement in the diverge/converge methodology:

[245] IDEO, *Executive TANG Workshop: Workshop Process Guide.*

[246] IDEO, "Design Thinking Workshop at Naval Postgraduate School."

> Having diverged and created many, many brainstorm ideas, now we're going to converge down and we're going to use prototyping, right? Simple, low-fidelity prototyping to actually give us a hands-on and visceral appreciation of what this particular tool might look like.[247]

The goal of this diverge and converge, generate and refine process is to gain input from multiple sources then focus collective energy to ensure superior creative output. The process is repeated incrementally until the desired end-state or output is reached. It is not the goal of prototyping to generate a complete, finished product. Rather, the goal is to provide innovative ideas that can be further refined by engineers into a buildable product. Prototyping, in this case, serves to enhance creativity while grounding the concepts in reality.[248] Figure 14 shows this concept.

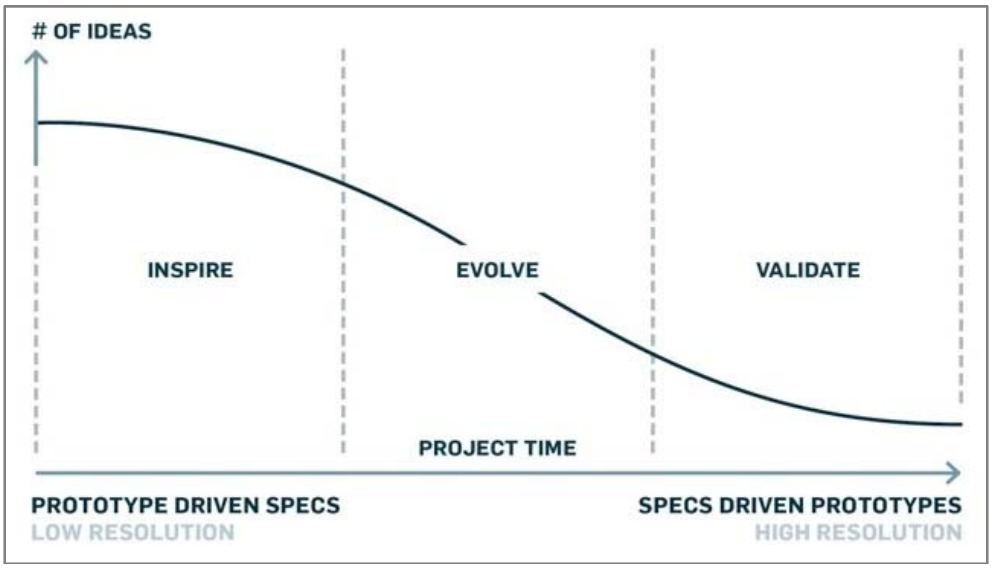

Figure 14. IDEO's spectrum of prototypes[249]

[247] Dave Blakely, interview by Robert Featherstone, September 4, 2013.

[248] Ibid.

[249] IDEO, *Executive TANG Forum*, Palo Alto, 2013.

F. OPENING THE APERTURE

1. Buzz from the First TANG

With the Executive TANG roster set, attention turned to determining what the invitees were in for. Most participants were aware, at least to some degree, of the initial TANG and its results, as they permeated the fleet, were almost all positive. "[When] the feedback from the sailors came out, it was very positive. They all wanted to attend after that," said Commander Kurt Balagna, serving on the staff of DEVRON-12 at the time of the initial TANG.[250]

There appeared to be a buzz from TANG that was fueling excitement for the upcoming Executive TANG, even at the top levels of Navy leadership. Former Master Chief Petty Officer of the Navy (ret.) Rick West tells of his reaction to learning about TANG:

> As MCPON, I had heard about the [TANG] initiative. It was really just in the early stages, so I really didn't have a good awareness [of it]…What I wanted to do was see how I could assist. As MCPON I had the ability to reach out to many personnel and had done so previously to determine what changes we could make to be more efficient and reduce redundancy…I was surprised at the input…when I found out more about TANG I saw some parallel efforts. Embracing the power of technology and applying it in a quick efficient manner through direct feedback or input is the cornerstone of TANG. Hopefully leadership will embrace this initiative…I never want to fight a fair fight…we've got to arm our Warriors with the education, skills and technology to remain at the top...[251]

One facilitator remarked enthusiastically to Josh Smith upon being invited to join the Executive TANG team, "This is really interesting, I'm finally part of the club, I'm finally inside the inner circle, TANG is this mysterious thing that people hear about and now I get to experience it."[252] Commander Steve Mongold, CO of the attack submarine USS *Montpelier* (SSN-765), echoed those sentiments. He recounted his feelings upon learning of his nomination to attend the Forum:

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[250] Commander Kurt Balagna, interview by Robert Featherstone, September 10, 2013.

[251] Master Chief Petty Officer of the Navy (ret.) Rick West, interview by Kevin Johnston, January 11, 2014.

[252] Josh Smith, interview by Robert Featherstone, August 22, 2013.

> I was like, yeah, that's something I'm very interested in participating in… I'm very interested in innovation and the techniques being employed to innovate, because part of my leadership challenge in my position right now is innovation and getting people to see a problem and attack it with non-traditional approaches. Or at least broaden their thinking to attack it.[253]

Commodore Parks summed it up: "It was incredible the response from [the first] TANG and that information was rolled into prototypes rapidly…and two years later it is now being tested at sea and used in our systems."[254]

Based upon the highly successful outcome of the first TANG, excitement for the possibilities of Executive TANG was definitely present among participants, facilitators, and sponsors alike. Though the first TANG had been a resounding success, the group attending Executive TANG was of a decidedly different composition—senior officers in command and leadership positions vice junior operators of systems.

2. Malleability Challenge

The success of TANG had proven that IDEO's methods could indeed be employed to promote creative and innovative solutions.[255] What was not known was how well senior leadership would respond to IDEO's methods. Firmly entrenched within the strict standards that permeate submarine culture, would this group of leaders be as open-minded to the IDEO process as the junior personnel had been? How well would the facilitators be able to penetrate the entrenched views and methods of the group? Scott Tupper of the DEVRON-12 staff described his initial reaction to the idea: "When we first started talking about [the IDEO process], 'Hey, this is their brainstorming process we're going to use and we're going to have them build things out of this foam core and tape, and this is what we're going to do…' When I heard that I said, 'You know, we're never going to get submariners to do this. We're just not."[256]

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[253] Commander Steven Mongold, interview by Kevin Johnston, September 10, 2013.

[254] Commodore Vern Parks, interview by Kevin Johnston, October 10, 2013.

[255] Hall, "A Case Study of Innovation and Change in the U.S. Navy Submarine Fleet."

[256] Scott Tupper, interview by Robert Featherstone, October 9, 2013.

While leadership had endorsed the concept of a command-focused TANG, fulfilling the original vision of Commodore Merz, this was no guarantee that the IDEO method would resonate. IDEO's Dave Blakely summarized his initial concerns during an interview in early September 2013, just prior to the commencement of Executive TANG:

> We're talking about…a justifiably proud set of individuals here and, if there's anything we've found at IDEO, it's that people don't react to systems or workshops or products or services the way you expect them to…I don't want to get into a dynamic where the folks that are attending and auditing are either being overly critical or over judgmental of early and embryonic ideas that come out. Because a lot of ideas, when they're in early stages, you know, they haven't been refined yet. And it's real easy to say, well, "That's clearly not feasible. You couldn't possibly do that." I want to make sure that innovation doesn't get squelched by people who might mean well, but who aren't exactly "down" with the program. So that's one of my worries.[257]

Though there was concern on the part of IDEO and their associated facilitators, top submarine leadership appeared to not share those concerns. Commodore Parks of DEVRON-12 was decidedly optimistic as to the abilities of senior leaders to suspend assumptions and participate actively in the IDEO process. The Commodore believed that the characteristics enabling these officers to be successful in command, under the demands of combat, would be the same characteristics that would add enthusiasm and richness to the collaborative process: "I actually went in thinking that we would have 27 individual sets of ideas that would never be able to overlap because of the type-A nature of our leaders, which is, in most forums that we operate in, absolutely what you need to be able to get the right robust debate…"[258]

IDEO, understanding the learning value of prototyping, knew they needed a prototype of the Executive TANG Forum itself—a "dry run" to flesh out how the process would go. They knew they needed a "risk mitigation prototype" to instill confidence that the IDEO process would indeed be effective and well-received by this relatively unique group of leaders.[259]

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[257] Dave Blakely, interview by Robert Featherstone, September 4, 2013.

[258] Commodore Vern Parks, interview by Kevin Johnston, October 10, 2013.

[259] Dave Blakely, interview by Robert Featherstone, September 4, 2013.

G. THE GROTON EVENT

In the weeks leading up to Executive TANG, IDEO and APL faced an atypical challenge. Due to the high-visibility nature of Executive TANG, it became evident that the facilitators needed to know how to best affect success.[260] In other words, they needed to conduct a dry run. How does IDEO prototype an interactive workshop? "These methods are pretty scalable," says Dave Blakely, so the team's solution was to simply scale down the scope of Executive TANG into a single 8-hour event.[261]

As with product design, the goal for this prototype is identical: learn about the interactive behavior of a group of senior submariners as they participate in the IDEO design process to glean new insights and further refine the process. Dave Blakely on the need for a prototype event: "We just wanted to breathe easy walking into Hawaii…I don't like it when people say, oh, it's going to be fine. Because people who have done anything in their lives never say that. They know all the things that can go wrong. And they're always worried about everything."[262]

With those thoughts in mind, the "pilot workshop" kicked off in July 2013, offering an "opportunity to test the agenda and HMWs and preview executive level concepts" with nine hand-selected participants.[263] In a 1-day session, the Executive TANG Facilitation Team executed a scaled-down design thinking forum, from end to end, with results that far exceeded expectations. During an IDEO design thinking event, initial prototyping involves the use of poster board, colored markers, pipe cleaners, twist ties, and sticky notes to engender a visceral and multi-dimensional understanding of the product under design. The goal of prototyping is to learn more about a particular design from which further insights may be gleaned and further refinement affected.

Guided by a set of problem questions similar to those that were *under consideration* for the Executive TANG Forum, the nine participants embarked on the

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[260] Josh Smith, interview by Robert Featherstone, August 22, 2013.

[261] Dave Blakely, interview by Robert Featherstone, September 4, 2013.

[262] Ibid.

[263] IDEO, *Executive TANG Forum*.

challenge of design thinking. CDR Kurt Balagna, one of the hand-selected participants, acknowledged that while the group rose to the occasion, it was not without a certain amount of skepticism:

> Oh, yeah, the group embraced [the process]. But it was [with]...the normal skepticism, I would tend to see. I mean, I was skeptical when I first heard about it...the culmination point was just going through a whole day and looking back…looking at how much we accomplished in 1 day. It really took that, because going through the first half of the pilot, it was like, what are we doing? What are we doing here? Where are we going next?[264]

Though there may have been pockets of skepticism present, the quality of the concepts produced by the group proved to be of such value that Dave Blakely re-characterized the event as a "mini-visualization," accounting for his belief that the designs produced were equivalent to the quality envisioned for the full Executive TANG Forum.[265] This was quite an accomplishment for a single-day's work. Though the intent was to mitigate risk through trial and learn in the process—the tangible end results of the Groton event were "three damn good ideas":[266]

- Central Automated Navy Objective Lessons-learned Inventory (CANOLI)–Geographically enabled lessons-learned library that offers commanding officers access to relevant lessons-learned for a particular geographic area. The data is sourced from the full submarine fleet and shared among all crews.
- Decision Support–Fused data system offering suggested courses of action to commanding officers for further consideration and comparison. Courses of action are developed using historical data, current intelligence, target plot, and threat conditions.
- Lessons-Learned Creation Suite–A quad plot combines rich media into a single file consisting of a narration video, fusion plot, common broadband, and all relevant data files. Allows a CO to record and play back an incident, positive or negative, and narrate it. The contents are easily formatted into an audio or video report using a simple template to enable sharing of lessons learned between submarines and crewmembers.[267]

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[264] Commander Kurt Balagna, interview by Robert Featherstone, September 10, 2013.

[265] Dave Blakely, interview by Robert Featherstone, September 4, 2013.

[266] Ibid.

[267] IDEO, *Executive TANG Forum*.

APL's Josh Smith was extremely enthusiastic as the pilot workshop came to a close. "It let me know that they would take to [accept] the process," said Smith, "especially the fact that IDEO was teaching them the process. They liked that…they were passionate about [the process]."[268] This observation is representative of the intangible result of the Groton event. Though concerns about participant malleability and process resistance were both well-founded and prudent, the Groton event demonstrated that those concerns were not insurmountable—that senior submariners were indeed capable of participating actively in the IDEO process, in spite of it running contrary to many of the long-standing tenets of submarine culture. The senior submariners learned from IDEO a new process, IDEO learned from the senior submariners that their facilitation methods were on the right track—the initial set of problem questions had resonated with the group and once they were set on course the submariners rose to the challenge of design thinking. By no means were IDEO's concerns alleviated altogether—but they had been lessened. IDEO knew they needed to remain attentive to framing the problems in a manner that would engage this unique group. They would need to invite process participation and creative dialogue. The Groton event had demonstrated the capabilities of senior submariners to suspend assumptions. With that in mind, the facilitators could now focus more on creating the most fertile creative climate possible and less on worries about participant resistance.

H. FINAL PREPARATIONS AND INSIGHT SYNTHESIS

Feeling less concerned about the willingness of their target audience and having just had a real-world demonstration of their initial set of problem questions, it was once again time for the facilitators to converge and execute a process of refinement. Through the course of numerous group telephone calls during late August and early September, what began as draft insights and potential HMWs slowly solidified into the final slate of insights and questions for the Executive TANG Forum.

Prior to the pilot workshop in Groton, IDEO and APL had considered presenting 11 insights broken down into three topical groups: 1) Leadership, 2) Systems, and 3) Data

[268] Josh Smith, interview by Robert Featherstone, October 25, 2013.

and Information.[269] After facilitating the pilot workshop in Groton and through a series of in-depth discussions between the facilitators, the three initial topical groups were reduced to two—"Systems and Information Flow" and "Command." During the same process, the total number of insights was pared from 11 to nine.[270] The "Systems and Information Flow" group contained insights targeted specifically at the technological systems and actual flow of information on the submarine that are both intended to enable the CO to make well-informed decisions but in actuality hinder him in some ways. For example, tactical systems used by Sonar Watch Standers and Fire Control Technicians have advanced greatly over the years yet if the CO is out and about on the submarine he still receives strictly audio contact reports and must synthesize that information *in his head*. Also, there is no automated system or standardized method for keeping up with the crew, undoubtedly one of the most important jobs of the CO. The insights contained within the 'Command' group were meant to summarize some key points about the burden of command such as empowering subordinates by promoting two-way communication and being able to manage the slew of on- and off-ship demands. These demands include nuclear reactor inspections, ship maintenance, ensuring sailors are trained on all systems prior to deployment, managing the ship's money and prioritizing spending needs, crew medical problems, personnel family readiness problems, managing a tight operational schedule ensuring adequate time off for the crew, and the list goes on and on. The final list of insights was:[271]

Systems and Information Flow:

- To support CO effectiveness, the design of communication and administrative systems and protocols must keep pace with the design of tactical systems.
- Integrating disparate systems, streamlining interfaces, and providing configurability will be critical to ongoing system development.
- Commanders are interested in the idea of a "Submarine Cloud," where all information is populated and shared, as a tool to unify the experience of interacting with disparate onboard systems.

[269] Josh Smith, email to Kevin Johnston, August 23, 2013.

[270] Ibid.

[271] IDEO, *Executive TANG Forum*.

- Information on the boat often lives locally rather than centrally, which can hamper collaboration and the ability to create a shared mental model.

Command:

- Enabling the agency of others is crucial to commanders' work. Two-way communication facilitates agency and a top-down only flow is not sufficient.
- COs are challenged to sustain energy and focus among the entire crew, across both routine and extreme times.
- COs experience tension in managing conflicting on- and off-ship demands.
- COs are tasked with providing leadership and sound decision making within a context of high ambiguity, synthesizing inputs from a multitude of sources (visual data, verbal communication, the "pulse" of the crew, e-mail).
- There are opportunities to more fully leverage information both onboard and across the fleet (such as lessons learned).

Insights are only half of the necessary input for a design workshop. While insights are by nature powerful statements capable of resonating deeply with a target audience, they lack a critical ingredient—a challenge to designers. The HMWs are specifically designed to fill this void, to challenge the design thinker to address the needs contained within the insights.

Once the facilitators had synthesized the new list of insights, the final step was to craft the proper set of HMWs. The task was not only to challenge the participants to think deeply and creatively but also to do so in a manner reflecting the many insights that were the foundation of the event. Through another series of in-depth dialogues, the facilitators focused on precise phrasing and semantic detail to craft the set of HMWs most reflective of the insights—remaining careful not to foreshadow solutions within the questions. The final list of HMWs (shown in Figure 15) was:[272]

- How might we capture lessons learned and improve feedback?
- How might we measure the tactical performance of the crew on a day-to-day basis?
- How might we leverage information flow up the chain of command?

[272] IDEO, *HMW Capture,* Palo Alto, 2013.

- How might we better coordinate competing operational priorities?
- How might we keep tactical interfaces simple and standardized?

Figure 15. Final Executive TANG HMW questions on brainstorming board[273]

As the first week of September drew to a close, the facilitators knew they had come a long way from the initial stages of research, when the problems to be grappled with at the Forum were loosely defined. Now that the insights were set and the HMWs finalized, it was time to let the design thinking process unfold. Everyone involved knew how much had gone into preparing for the event but it remained to be seen what the outcome would be. The question still remained: how would this group of senior officers respond to the design thinking process?

I. THE EXECUTIVE TANG FORUM

1. Day One–Registration and Tech Expo

On Monday September 9, the Executive TANG Forum commenced. The facilitation team, staffed largely by members from APL and IDEO, arrived around 10 in the morning to finish setup in the main sharing room and breakout areas. Later that morning, representatives from Microsoft, Google, Adobe, Metron, In-Depth, and Monterey Technology arranged kiosks for the "Tech Expo" which would bring participants up to speed on some of the latest technologies these companies had to

[273] IDEO, *HMW Capture.*

offer—the overall goal of this was to *inspire* participants, not to sell them products.[274] Figure 16 shows one of the signs erected by the Forum facilitators in the Tech Expo Area.

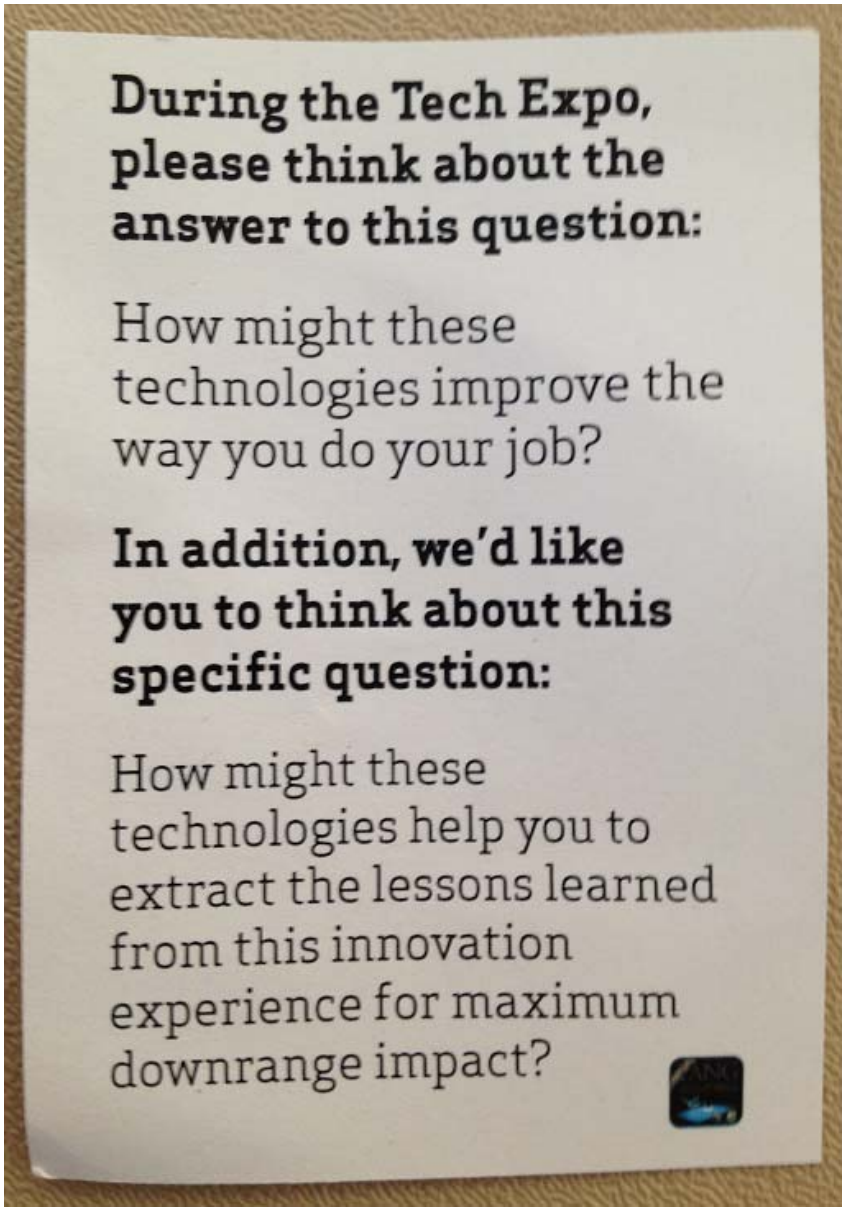

Figure 16. Tech Expo challenge question

[274] Josh Smith, interview by Robert Featherstone, August 27, 2013.

As Forum participants arrived, they were greeted by facilitators dressed in Hawaiian shirts and casual chinos. Upon registration, participants were assigned to one of three teams: Barb, Tang, or Wahoo. Each participant was given a name tag containing their first name in large bold font, their team name, and their whole name (first and last) in small text. As participants registered, they were allowed to mingle with other participants and explore the Tech Expo until the event officially kicked off at 1700. During this open time, the majority of participants who meandered to the Tech Expo consolidated at the APB-13 booth—Microsoft, Google, Adobe, Metron, In-Depth Engineering, and Monterey Technology received minimal attention.

The Forum participants represented mid-level leadership in the Navy's prestigious submarine community. Individuals ranged from Lieutenant Commander (O-4) to Captain (O-6) representing anywhere from 14 to more than 22 years of naval service. Because of this, most participants knew each other but at the minimum at least knew *of* each other.[275] During the mingle period before the official start of the Forum, one participant remarked "It's basically like a reunion in here right now—we have like a 6-year spread of guys here that all pretty much know each other."[276]

At approximately 1700, registration was over and the event officially began with remarks from the DEVRON-12 Commander, Commodore Parks. During this intro, he presented Josh Smith from APL as well as the rest of the facilitators and placed special emphasis on the crew from IDEO, headed up by Dave Blakely. Dave Blakely then followed with a quick explanation of technical innovation with focus on tech push versus tech pull, which set the stage for introductions from each of the Tech Expo vendors. These vendors were expected to "present what is new and cool but were not supposed to revert to a simple sales pitch."[277] The Tech Expo vendors provided quick speeches (approximately 5 minutes in duration) covering the most important points of their products. Of note, when the Executive TANG preparation and planning first commenced, these briefs were planned to last 15 minutes each. Josh Smith and his facilitation crew,

[275] Anonymous, remark to Robert Featherstone, NS Pearl Harbor, HI, September 9, 2013.

[276] Ibid.

[277] Dave Blakely, interview by Robert Featherstone, September 4, 2013.

however, learned that using a *pecha kucha*, or a 5-minute high-level brief, was the way to go.[278] According to Josh, this type of brief was well received at the previous TANG because "if you let a presenter go for an hour, you'll lose them and we need to keep the energy up."[279] Of note, participants seemed energized in response to the representative from In-Depth Engineering who energetically briefed an automated torpedo warning system, a touch enabled geographic display, and a new electronic intelligence analysis display. Google also captivated the audience with a demonstration of their cutting edge Google Glass.

At approximately 1900, the intro briefs were complete and Josh Smith gave closing remarks to the group releasing the participants to head back to their hotels to get some much-deserved rest prior to the start of Day Two when most of the heavy lifting would start (many participants had traveled from California and as far as Groton, Connecticut to attend the event). At 1930, despite exhaustion and hunger, most of the participants were still at the Forum mingling with each other as well as the Tech Expo representatives. Figure 17 shows some of the Forum participants interacting with the representative from Monterey Technology.

[278] Josh Smith, interview by Robert Featherstone, October 25, 2013.

[279] Ibid.

Figure 17. Monterey Technology Tech Expo booth

2. Day Two–The First Full Day

The second day of the Forum began at 0730 with a buffet-style breakfast. During breakfast, participants continued to interact with each other as well as the facilitators and observers. During this time, when asked about the event one participant commented "Everyone seems positive about the experience. I was an XO during TANG 1 so I had to send one of my guys—he came back with nothing but good things to say about the experience so I was excited to come to this one."[280] Another participant remarked "On the boat, I'm always like 'hey even if you don't like the system, it's what we have so get good at using it.' I was excited when I got invited to come here so I can maybe affect systems of the future."[281]

After breakfast, Rear Admiral Sawyer, Commander of Submarine Forces U.S. Pacific Fleet, delivered opening remarks to the group. During these remarks, the Admiral relayed to the participants that each of them was hand selected to participate in the Forum

[280] Anonymous, remark to Robert Featherstone, NS Pearl Harbor, HI, September 10, 2013.

[281] Ibid.

and expressed that his expectations were high for the event. He ended his remarks with emphasis on the importance of diversity of ideas and backgrounds and announced that a golf event was being held Thursday morning——and that all Forum participants were invited. Although not scheduled in the events for the Forum, Josh Smith and the facilitation team quickly adjusted the weeks' events to make room for the Admiral's golf outing.

a. Introduction to the Process

Immediately following Rear Admiral Sawyer's remarks, IDEO facilitator Dave Blakely delivered an introduction to Design Thinking where he explained that design thinking is all about *alternating cycles of convergence and divergence* and expressed to the group that innovation is creation resulting from study and experimentation. Figure 18 shows this introduction. He also emphasized that design thinking is a learnable skill. This class was followed by a discussion led by IDEO's Dan Soltzberg on the importance of insights in the IDEO design thinking process with time spent on the actual insights for the Executive TANG Forum and how those insights were developed.

Figure 18. Dave Blakely instructing the Executive TANG Forum in the sharing room

b. Overcoming Barriers

After participants received instruction on design thinking and insight development, they were sent away to the three breakout groups—Barb, Tang, and Wahoo. Each team was assigned at least one facilitator from IDEO and one or two facilitators from APL or other agencies supporting the Forum (e.g., Lockheed Martin). Upon reaching the breakout rooms for the first time, participants were greeted by pre-arranged rooms laid out with IDEO's tools for design thinking—sticky notes, large white boards, construction materials, etc. (Figure 19).

Figure 19. Team Barb breakout room

Upon settling in to the breakout rooms, the facilitators set the stage for the development of HMWs based off the IDEO-prepared insights for the Forum. In Figure 19, IDEO's Dan Soltzberg is leading Team Barb in their first development of problem questions (HMWs). This was followed by group *divergence* so that each participant could personally develop a few HMWs. As the first exercise of the Forum, some participants

seemed confused at first; one team member remarked "What is the overall goal?—maybe I'm the only one who doesn't understand."[282]

After spending about 15 minutes developing descriptive problem questions, the next step in the days' events was an interview exercise (Figure 20). During this exercise, each team would be split in half and then half of each team would rotate to another team to conduct the exercise—for example, half of Team Barb would switch with half of team Wahoo and members of the two teams would interview each other. According to one of the facilitators, the purpose of the interview exercise was to serve as an ice breaker of sorts and also give everyone a chance to practice active listening skills and develop a deeper sense of user empathy. As noted by IDEO, "the most powerful inspiration for innovation is the empathy that comes from authentic appreciation of the needs of stakeholders."[283] Just as IDEO gains empathy to inspire their own innovative energies, they believe in offering the same opportunity to participant designers. The interview exercise offers a chance for end users to add depth to their empathetic appreciation of others who are beholden to ineffective processes or systems. In this case, submarine officers looked over the insight syntheses given to them by IDEO and interviewed one another about their thoughts and perceptions. The goal of this portion of the process is to add depth to participants' understanding of the needs that they are about to address.[284]

Though the goal of the exercise may have been empathetic appreciation, the exercise was met with some skepticism by participants. Just prior to the start of the exercise, one of the members of Team Wahoo remarked "Wow, there's nothing awkward about any of this."[285] At the Groton "pilot workshop" event, attendees also conducted an interview exercise, but the general consensus was that this exercise was disconnected and did not bear any fruit from the perspective of the participant.[286] The facilitators of the Executive TANG, however, decided to conduct the exercise anyway, due to their belief

[282] Anonymous, remark to Robert Featherstone, NS Pearl Harbor, HI, September 10, 2013.

[283] IDEO, *Executive TANG Forum*.

[284] Ibid.

[285] Anonymous, remark to Robert Featherstone, NS Pearl Harbor, HI, September 10, 2013.

[286] Kurt Balagna, interview by Robert Featherstone, September 12, 2013.

that participants must develop the critical emotion of user empathy. They must understand the feelings of users who are troubled by the inadequacies of the information display capabilities contained within their current systems. After the interview exercise was over and the groups resumed their original composition, one Team Barb member sarcastically remarked, "We can conclude the conference—I solved it."[287]

Figure 20. Participants from different teams interview one another to gain user empathy.

Once the interview exercise concluded, each group took time to continue development of problem areas of interest followed by a group explanation and download where each team member explained how they came up with their suggestions and physically attached their sticky notes to the idea clustering board. Figure 21 shows one of the initial idea boards after the first round of brainstorming on participant-developed problem questions.

[287] Anonymous, remark to Robert Featherstone, NS Pearl Harbor, HI, September 10, 2013.

Figure 21. Suggested problem areas for inquiry

Figure 21 includes an eclectic mix of participant developed problem areas:

- "Alarms"—representing the participant's desire to include automatic triggers that would alert the CO when a threshold has been exceeded.
- "Latency of Data"—data that arrives too late (high latency) could be useless to the CO in a situation that is rapidly evolving.
- "Crew Performance"—the performance of the crew will directly affect the overall performance of the submarine.
- "Important Info Gets Priority"—in an environment saturated with information, the CO must be able to determine which information matters and what does not.
- "Truth versus Estimate"—as information becomes more accurate, it gets closer to the truth. Being able to distinguish the accuracy of information to determine its validity is crucial.

- "Capture Knowledge over Time"—as the situation picture constantly changes on an operational submarine, it is important to be able to reference past data to conduct trend analysis in an effort to better forecast future events.

Given the seniority and experience of individuals in the groups, some participants had as many as 10 ideas to share during this download session, which resulted in time elapsing without all team members being afforded the opportunity to share their ideas. At the Team Tang explanation and download session, only four of the eight officers in the group were able to share their ideas. Participants then went back to the main sharing room where they received a class on brainstorming by Dave Blakely. After this class and an overall exhausting morning, learning and applying IDEO's techniques for design thinking, it was apparent that everyone was ready for a much-deserved mental break over lunch.

c. Lunch

After 4 hours of arduous and unfamiliar work, everyone was ready for lunch. Unfortunately, due to schedule changes and logistical challenges, the Forum facilitation team found out at the last minute that lunch would be about an hour late. To fill the time gap, IDEO Partner David Haygood gave a few very brief presentations on recent IDEO efforts. Once that was complete, Forum attendees were allowed to socialize with each other and wait for lunch to arrive. As time went on, participants began to grow more and more restless while some facilitators also showed frustration in the schedule snafu. Approximately 45 minutes later, lunch arrived and all was right again at the Executive TANG Forum.

d. First Attempt

After lunch, the groups went back to their break out rooms to develop "how might we" questions addressing previously mentioned problem areas. After a period of divergence to develop the HMWs, the group converged again to review and vote on the HMWs that were previously generated. To vote on HMWs, participants used small circular stickers to visually express their interest in the problem question. The voting process took approximately 20 to 30 minutes, depending on the group, and resulted in the

convergence on a smaller group of HMWs for each team. Figure 22 shows the HMW board after Forum participants completed voting.

Figure 22. One of the HMW voting boards

Certain HMWs received high attention as they were easily and directly relatable to current needs of the commanding officer—each encompassing multiple problem areas developed earlier in the process. For example, the problem areas “Truth versus Estimate” and “Important Info Gets Priority” were addressed by asking, “How might we promote simplicity without compromising content?” Other key problem areas, “Capture Knowledge over Time” and “Latency of Data,” were merged into a different problem question: “HMW capture and promulgate consistent and constant data across platforms and timeframes, making it easily editable by all and searchable.” These questions address the importance of prioritizing information and distinguishing between various levels of accuracy (truth); and continuously collecting data as the submarine progresses through its mission, ensuring that it is distributed in a timely fashion.

After convergence on a few HMWs, next on the agenda was a practice solution-generation brainstorming session. First employed at the Groton event, the practice brainstorming sessions were intended to be focused on an area unrelated to the submarine community that could be understood by all participants. One group decided to do their brainstorming session around "How might we sell a boat?" Tony Patron, IDEO facilitator for Team Tang, realized his team was still somewhat discouraged after the lunch episode, decided to ask if the team would like to brainstorm "how might we have fixed the lunch crisis?" This HMW was met with instantaneous enthusiasm and seemed to unite the group behind a common issue. It also served to demonstrate the broad applicability of IDEO's brainstorming techniques.

After the practice brainstorming session, each group conducted follow-on brainstorming sessions focused on previously voted upon HMWs. Each group seemed to grow increasingly comfortable with the brainstorming process as the session went on. The groups then divided up to focus on rapid prototyping physical representations of their ideas that emerged from the brainstorming session.

e. Share Back

At the end of Day Two, the first full day of the Forum, the groups re-assembled in the group sharing room to conduct "share backs." Facilitated by Josh Smith, the goal of this event was for each group to give a quick 1-minute brief of each of the ideas that would serve as a wrap-up of the day's events and help the participants see how far everyone had come through just 1 day of brainstorming and rapid prototyping. For example, one group gave a quick 1-minute brief about their idea to design a system that would monitor the status of the entire submarine to include equipment status and crew proficiency—this system would also be scalable for application to multiple echelons within the submarine community. According to Andy Leal, facilitator for Team Tang, these first group presentations are helpful in focusing all the groups because the participants actually see the other groups presenting different ideas.[288] Josh wrapped up the day's events and gave praise to the group on a job well done.

[288] Andy Leal, interview by Robert Featherstone, October 25, 2013.

f. Pivot Meeting

According to one of the facilitators who had participated in all preceding TANG events, hot washes at the end of every day are very important to redirect group efforts if necessary—at the end of day one during the first TANG event, the Commodore had to do a big re-direct because one of the groups went "deep down a rabbit hole, in the wrong direction."[289] In a similar fashion to previous TANG events, when the participants were released for the day, the facilitators rallied at the front of the group sharing room to have a staff huddle and discuss the days' events.

At the hot wash, there was some concern that most of the ideas that were presented during the share back were already being worked on in the submarine community. After a few minutes of debate, Josh calmed the group by explaining that a pivot at this stage of the Forum was completely acceptable and in fact they had done that at previous TANGs. The group discussed whether it would be best to tell the Forum participants specifically what they wanted explored or figure out a way to guide the process somewhat or continue to allow completely unhindered creativity. The pivot meeting adjourned with the conclusion that Commodore Parks and/or Mr. Pete Scala from IWS 5 would address the group at the start of the next day—but with no fidelity on the actual nature of the remarks.

3. Day Three–Back to Work

a. Commodore Parks' Remarks

Day Three began with a working breakfast immediately followed by opening remarks from the Commander of DEVRON-12. Commodore Parks began by introducing Procurement Management System (PMS) representatives in attendance as it will be their offices who will implement the concepts developed at the Forum. He pointed out Captain Bradford Neff representing the Submarine Acoustic Systems Program Office (PMS 401), Captain John Zimmerman from the Submarine Combat System Program Office (PMS

[289] Anonymous, remark to Robert Featherstone, NS Pearl Harbor, HI, September 9, 2013.

425), and Captain Steve Debus from the Submarine Sensor Systems Program Office (PMS 435). Figure 23 shows the interaction between these PMS representatives and IWS:

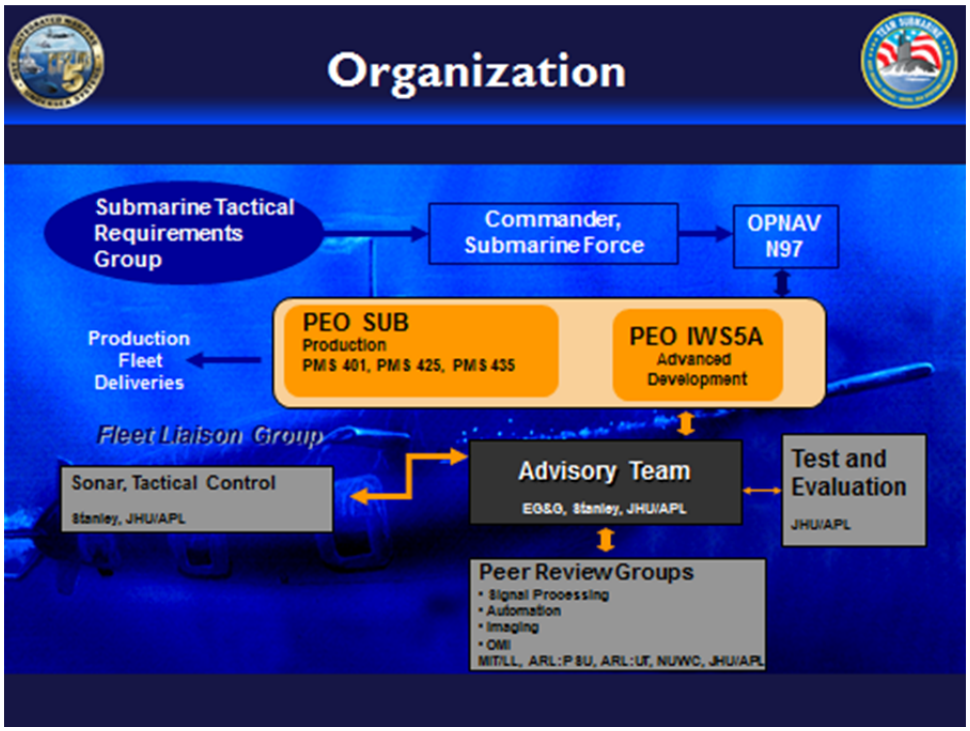

Figure 23. Interaction between PMS and IWS offices[290]

Introducing these acquisition professionals set the stage for his guidance on the way ahead for the Forum:

> The vast majority of these things are currently being worked [for future APBs]. I want you to identify exactly what you want to see in those systems. Peel back the onion a bit. Also, look at training for systems and think about the widget that we don't have and open the aperture. What's next? That's the real question.[291]

b. Refinement, Development, and Concept Review

After Commodore Parks' remarks, groups went back to their breakout rooms to review concepts from Day Two and conduct further brainstorming. While some groups

[290] Josh Smith, email to Robert Featherstone, February 23, 2014.

[291] Commodore Vern Parks, interview by Kevin Johnston, October 10, 2013.

got right to work, others were somewhat slow to get started, as evidenced by sidebar conversations unrelated to the Forum, the taking of outside phone calls, and/or lingering in the coffee area. Facilitators took a more active role during Day Three to keep participation motivation as high as possible. At about mid-day, the Forum was re-assembled in the main sharing room for design reviews. During these reviews each group presented a more detailed version of their idea from Day Two, including a physical prototype. Also, each concept was identified by a formal name—some names used were Battlefield Operational Management Board (BOMB) and Section Health & Integration Program (SHIP). The main purpose of this concept review session was for each concept to be briefed to the group in about 5–7 minutes and allow for group feedback (Figure 24).

Figure 24. Participants briefing during the concept review session

In Figure 24, three participants are briefing their concept to the larger group. In the brief, the submarine officer holding the microphone is *explaining* the nuances of the developed concept while the other officers simply hold the prototype. At this stage of the

process, the goal is simply to explain the concept using the prototype to elicit further feedback.

After the first concept was briefed, the group was afforded the opportunity to provide constructive criticism. Initially, feedback being provided by the group was minimal. After a substantial lull, however, a participant jokingly broke the ice saying "Like a good nuke, I hate change but I really like what you did with this."[292] After this comment, the group chuckled and appeared to relax. This small action seemingly resulted in reducing the level of personal restraint in the room, increasing feedback for all remaining teams presenting their ideas.

After concept reviews and lunch, most groups seemed to suffer from a drop-off in productivity—when they all went back to their breakout rooms, the energy level was definitely not as high as it had been.[293] According to Scott Tupper, a veteran of previous TANGs, there is usually a dip during the afternoon of the second full day of work—typically because participants get somewhat lost on where to go next.[294] In an attempt to breathe some new life into the group, Josh Smith decided to inject some of the Tech Expo personnel as well as some submarine junior officers from NS Pearl Harbor into each of the breakout groups (Figures 25 and 26).[295] The Tech Expo representatives were well received across the board as they brought unique subject matter expertise and experience to the brainstorming sessions.

[292] Research Observation, NS Pearl Harbor, HI, September 11, 2013.

[293] Josh Smith, interview by Robert Featherstone, October 25, 2013.

[294] Scott Tupper, interview by Robert Featherstone, October 9, 2013.

[295] Josh Smith, interview by Robert Featherstone, October 25, 2013.

Figure 25. A representative from Monterey Technology demonstrates the use of a mission planning tool to members of Team Wahoo as a way to spark some creativity into their brainstorming session.

While the Tech Expo personnel were well received by all groups, the junior officers were met with mixed emotions. These junior officers, mostly Lieutenants and Lieutenants Junior Grade, are the very officers that would typically stand watch on the submarine *under* the command of an O-5 or O-6 just like those conducting the brainstorming and prototyping at this Forum. Because of this, some of the breakout groups welcomed the JOs while others wanted nothing to do with them. According to Andy Leal, facilitator for Team Tang, incorporating the Tech Expo and junior officer personnel into the breakout groups was a good move:

> It was fun and great at the same time. The junior officer personnel didn't know who they were talking to [since Forum participants were in relaxed

civilian clothes with name tags that highlighted first names] so they spoke frankly. The TANG group initially had the look of 'who do you think you are.' But they became more open minded once they started receiving good feedback.[296]

Figure 26. Two Commanders (O-5s) from Team Tang brief their COSTAR concept to junior officers to get a different perspective.

c. RADM Sawyer Visit

On the morning of the third day, Josh Smith received word that the Commander of Submarine Forces Pacific, Rear Admiral (RADM) Sawyer, would drop by the Forum in the afternoon for an in-progress review of sorts. A walk through each of the breakout groups would be conducted to show the Admiral just what was being done. After word was received by each of the teams, each group then designated a briefer and began preparing what would be shared with the Admiral.

Early in the afternoon, RADM Sawyer arrived at the Forum and was escorted by Josh to each of the breakout rooms. At each room, the Admiral was met by energetic

[296] Andy Leal, interview by Robert Featherstone, October 25, 2013.

team participants for a brief on each of the concepts they were developing. Each of these briefs lasted approximately 5 minutes. The motivation level at each of these briefings was much higher than expected after the previous lull in the day's energy levels. All in all, the visit by RADM Sawyer lasted just over 1 hour.

4. Day Four–A Shortened Final Day

Immediately after the start of the Forum, Josh and the facilitation team had to make schedule changes due to the unforeseen golf outing. Scheduled for 1130 on the fourth day of the Forum by RADM Sawyer's staff, this golf event would serve as a fun social event immediately following the hard work completed at the Forum. Day Four was originally planned to end at 1430.

When participants arrived the morning of Day Four, they were given just over an hour to refine their concepts for the final presentations. The final presentations of all concepts would be skits where participants on each of the teams would actually act out the concept in a few different scenarios. The larger group would then be allowed to once again provide feedback.

a. Skits and Group Feedback

Team Tang was the first group to brief their concepts during the final skits. Of note, skits were not part of the original timeline of events at the Executive TANG. Originally participants were expected to simply brief their concept. As a way to promote ownership of the concepts and breathe extra life into the concept development, however, Josh Smith and the facilitation team decided to require the groups to actually act out their concept in multiple scenarios. The Commanding Officer Safety and Tactical Automated Reporting System, or COSTAR, was the first concept acted out. Commander Kurt Balagna, the junior member of Team Tang, energetically led his team in demonstrating the idea. The COSTAR concept was designed to allow the CO to be *anywhere* aboard the submarine and continuously capture information over time as quickly as it could be delivered to him. Furthermore, the system addressed the participants' desire to have pre-programmed alarms set that would alert the CO when certain conditions necessitated his direct involvement (Figure 27).

Figure 27. Team Tang acting out the final skit for the COSTAR concept

In Figure 27, the team simulated a commanding officer sleeping when an alarm alerts the CO to a report coming in from the OOD via a tablet, informing the CO of a new contact being negotiated by the crew. Next, the group acted out a scenario in which the CO was running on a treadmill and received another report from the OOD via the same mobile tablet. As the participants simulated running on a treadmill by actually running place on the stage, the rest of the group initially chuckled at the clumsy nature of the task at hand but then became more involved in the concept as they immersed themselves in the on-stage action.

After the skit was complete, the rest of the Forum was allowed to provide feedback to the Team Tang COSTAR group. The participants were asked to form their feedback in one of four categories—*I like, I wish, What If, and I'm Concerned*. For example, if someone in the Forum wanted to see another capability added to COSTAR, they would say "I wish…" Figure 28 shows the final concept board for COSTAR.

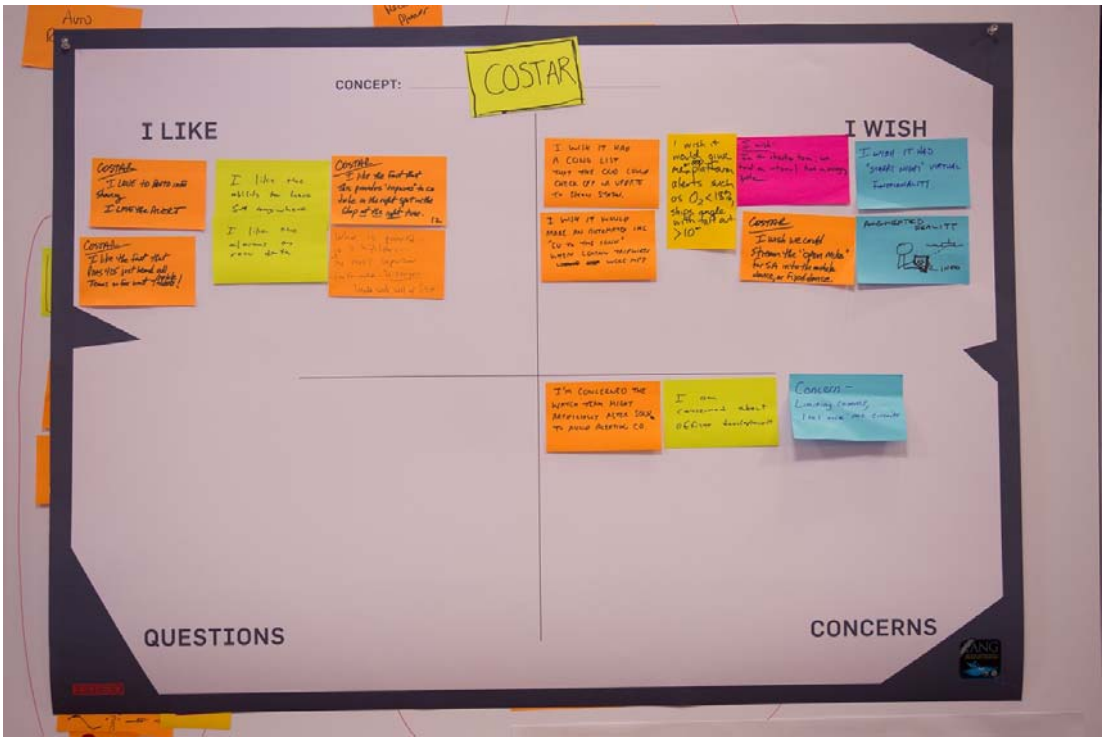

Figure 28. COSTAR concept board

The Concept Board includes the following:

- "I like the ability to have SA [Situational Awareness] anywhere."
- "I Wish it would make an automatic 1MC [ship wide public address] call "send the CO to the Conn" when certain tripwires [conditions] are met."
- "I am concerned about officer development"—this concern stems from the fact that with the CO possessing a mobile tablet, the junior officer would no longer be physically face-to-face with the CO. Also, the CO is *always* available to make a decision, depriving the JO from the opportunity to develop his own decision-making abilities.

A few more concepts were briefed after COSTAR before skits were temporarily halted in anticipation of RADM Sawyer arriving at the Forum for a final appearance. The admiral arrived and gave final remarks to the group where he focused on the value of thinking outside the box as well as receiving feedback from others—two key skills that were demonstrated at the Forum. He thanked the group for their hard work and then had a separate behind-closed-doors conversation with the IDEO facilitators before departing the Forum.

After the admiral left, the remaining concepts were briefed in skit fashion. Based off feedback from the concept review session the day before, the Tang Group *added* a concept called AIM or Attack in a Minute which would serve as an automatic and dynamic torpedo preset calculation engine. The other major change from the previous concept review session was that two concepts from two different teams were merged into one super concept. During the previous concept reviews, Team Barb presented a concept they called Wardroom Horizontal Integrated Planner (WHIP) while Team Wahoo presented Submarine Operations Navigation Integrated Console (SONIC). After these groups presented their individual ideas during the concept review sharing session, they realized the concepts had significant overlap and could be merged into a single overarching concept. While not planned or standard in TANG Forums, facilitators encouraged this pivot from the norm and allowed these two groups to merge and develop a super concept representing the design efforts of both Team Barb and Team Wahoo. During final skits, a single combined concept was briefed as SONIC-WHIP—a touch-enabled horizontal planning table permitting layered presentation of operator-selectable information.

In all, eight conceptual skits (described in Appendix B) were performed by the Executive TANG participants, each uniquely addressing the identified needs of those who had developed the concept. The eight proposed solutions spanned the range of the problem space, some addressing technical solutions to tactical problems, others attempting to provide greater detail on personnel, training, and readiness concerns.

In one example, Team Wahoo tackled the problem of lessons-learned documents not being distributed or accessible in a user-friendly manner by proposing a system they called “SUBIPEDIA.” In contrast to the current method of distributing lessons-learned or after-action reports using naval message traffic (similar to official email), which are often dense and difficult to understand, SUBIPEDIA offers a Wiki-style system in which fleet user input is collected and categorized under easily understood concept headings and populated across the entire submarine fleet. The system would permit access to unclassified as well as classified information through a single source that offers comprehensive information on a given topic that has also been vetted or “crowd sourced” through a social-media-style helpfulness rating method. Suppose a commanding officer

needed to bring the submarine into a port with which he is unfamiliar, he could reference SUBIPEDIA for all observations, advice, and lessons-learned from the commanding officers who have gone before him. This would also include ratings from his peers on which pieces of information are particularly useful, important, or impactful. SUBIPEDIA, therefore, offers the CO a wealth of useful information while reducing the amount of time he must devote to multi-source research. Furthermore, by relying on the experience and knowledge of his peers, he is tacitly harnessing the collective wisdom of the entire fleet of commanding officers.

While SUBIPEDIA addressed concerns related to information sharing and the identification of what is critical knowledge for the CO to have at his disposal, Team Tang designed a system that automatically computes the position of a sonar contact using advanced sonic algorithms. Automated Solution Development (A.S.D.) would develop position solutions and present those to the human sonar operators who would then evaluate the computer's estimate and either accept it or alter it. A.S.D. would ease the workload on sonar and sensor operators in detecting and correlating contacts, freeing more of their mental energy to assist the CO in developing and tackling the overall complexities of the mission. With more energy devoted to focusing on the handful of contacts that really matter, leaving the computer to handle the less-important or farther-off contacts, the watch team becomes more effective at keeping the submarine safe while conducting operations. The result is a commensurate easing of the mental workload on the CO, helping him to better execute his mission.[297]

b. Participant After Action

After skits were complete, Dave Blakely from IDEO congratulated the group on a job well done during the Forum and asked for feedback on the orchestration of the workshop. A participant from Team Tang immediately spoke up stating that he liked the process but that a summary of technologies currently being worked would have been helpful at the start of the Forum. Multiple participants then followed his lead stating that they wished they had been provided with the brainstorming process in advance—a "read

[297] IDEO, *Executive TANG Forum*.

ahead" of sorts. After a few minutes discussing a possible "read ahead" option for future TANGs, the following insights were provided by other participants:

> I really like the process but my concern is cost. I wish we could build expertise in the Navy to use the [design thinking] process.
>
> Whoever got the idea to help the sub-community, I applaud you. Can we expand this to other areas on the sub?
>
> I recommend getting a bunch of enlisted guys together to try to make life in port better.

c. Commodore Parks' Closing Remarks

Despite being at the end of a demanding Forum where more senior officers had been introduced to a new way of generating solutions to complex problems, the morale and energy seemed quite high at the end. With the last skits finished and IDEO done conducting a casual hot wash, Commodore Parks provided the following closing remarks:

> Thanks to IDEO; the how might we process continues. We take these ideas and hot wash them and produce products for the next APBs–APB 15 through 17. This is part of a larger fleet input process. More specifically, the input process that is generated from the Submarine Tactical Requirements Group, I'm the chair on that. Early on, we focused on operational planning and safety. By the end, a few groups were focused on combat. Thank you for doing that. This is what we do. We are warfighters first.[298]

d. Facilitator Synthesis Meeting

After the hot wash and closing remarks, participants were released from the Forum to attend the Admiral's golf outing. With the Tech Expo personnel breaking down their displays and the clean-up crew going through all Forum spaces, all members of the facilitation team gathered together to immediately begin development of the official Executive TANG output documents. Goals for the synthesis meeting included:

- Final text for IDEO concept presentation
- Image sketches for IDEO presentation
- Storyboards

[298] Commodore Vern Parks, interview by Kevin Johnston, October 10, 2013.

- Capture nature of the concepts
- Document write-up

Led by Dave Blakely from IDEO, the team pressed forward in a collaborative session and hammered out the details for each of the goals. The team spent the remainder of the day Thursday and the entire day Friday finalizing products so they could be briefed to all stakeholders.

J. EXECUTIVE TANG OUTPUTS

Upon concluding the Forum and returning to the mainland, IDEO and the team of facilitators still had the tough task of crafting a brief containing the outcomes of the event. Not only did they need to capture the essence of the concepts developed by the participants, they also needed to describe, for those not in attendance, what had occurred during those four busy days. With notes in hand from the synthesis meetings, another round of collaborative phone calls commenced. During these calls, descriptions and drawings of the concepts developed during the Forum were fine-tuned, taking care to ensure that they remained true to the desires of the groups that had created them.

The team's task was deeper than simply providing a brief description of the concepts with a few accompanying bullet points. Their task was not only to describe but to contextualize the use of the concepts to the briefing audience through well-thought-out drawings—just as the skits had contextualized each concept for the audience at the Forum. To accomplish this, IDEO's team of graphic artists developed initial drawings that were then circulated among the group of facilitators. Once digested by the group, critique and feedback were provided in order to refine them, ensuring they were indeed true reflections of the concepts.[299]

An example of the descriptive treatment given to one of the concepts, the "C.O.S.T.A.R." or Commanding Officer Safety and Tactical Automated Reporting System, is provided in Figure 29. It is important to note that the visualization is not focused solely on the technology but also includes a depiction of an operator employing

[299] Research observation, NS Pearl Harbor, HI, September 11, 2013.

the technology—providing the critical human-centered element that is the hallmark of design thinking.[300]

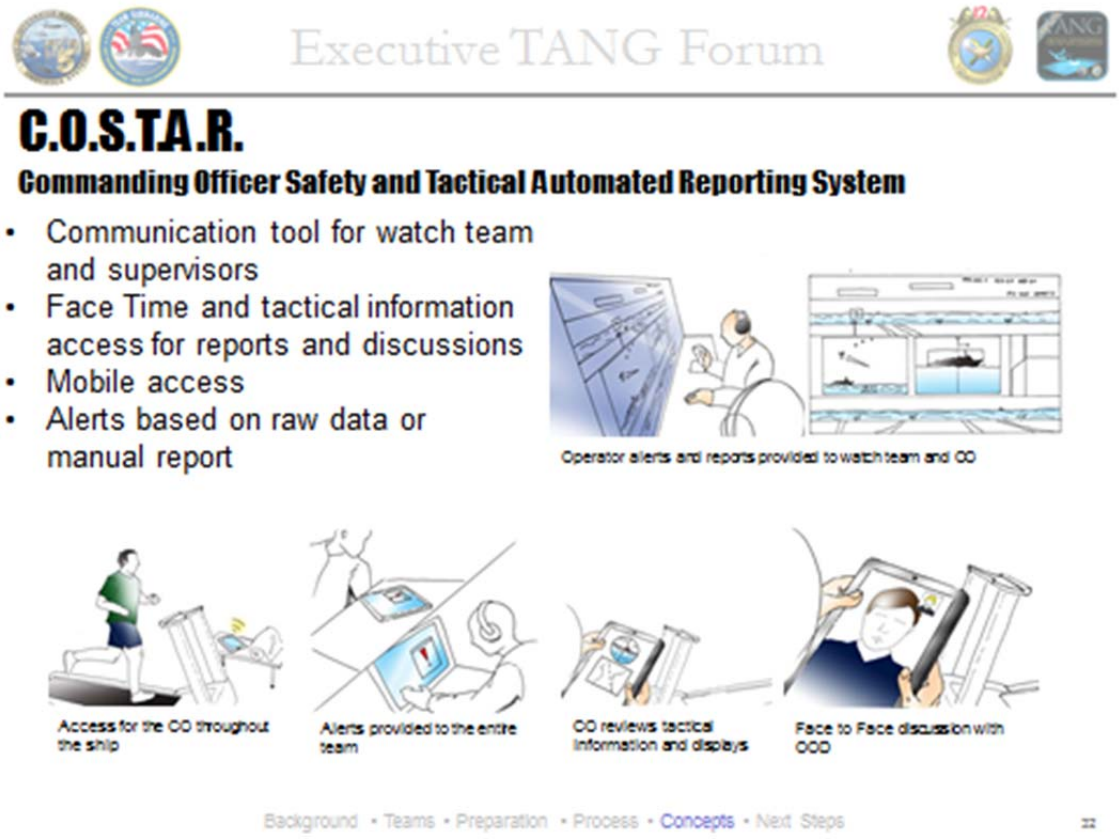

Figure 29. Conceptual Description and Visualization of the COSTAR Concept[301]

As the facilitators reflected on the 11 concepts, some overarching conceptual themes emerged. Taken in sum, the outputs of the Forum appeared to express a desire for reduced workload through automating, which would enable the operators to focus less on system manipulation and more on solving the tactical problem; flexible data visualization and layered information, which would allow for system customization based off mission requirements; a single system with integrated information from multiple sources in order

[300] Charles Owen, "Design Thinking: On its Nature and Use," in *Rotman on Design*, ed. Roger Martin and Karen Christensen (Toronto: University of Toronto Press, 2013).

[301] IDEO, *Executive TANG Forum*.

to reduce the amount of information melding that the human would have to do; knowledge sharing and the quick distribution of lessons learned to improve future performance based on past experiences of the collective; ship and crew status information to better support decision making and risk assessment; and multi-touch tables, wireless connectivity, and mobile devices to leverage the most-current commercially available technology to improve display and dissemination of information. These overarching conceptual themes appeared in the participant-developed concepts satisfying the overall goal of the Forum—*improving command effectiveness*.[302]

With the concepts properly visualized and the overarching conceptual themes identified, it was time to brief the stakeholders of the TANG and ARCI processes—the same stakeholders of the submarine, acquisition, and leadership communities who had supported Executive TANG and were awaiting the outcome. To some degree, this marked the end of the design thinking process and the cycles of divergence and convergence. Though design thinking and the process of collaborative innovation garnered most of the attention surrounding the events of Executive TANG, the mission of the Forum remained unchanged: to innovate new technology to aid commanding officers in the execution of their duties. At this transitional point, the future of the concepts developed at the Executive TANG now lay in the hands of those within the established research, development, and acquisition communities. For the Executive TANG concepts to have a future in the fleet, they must be integrated into the existing APB and TI processes.

K. THE ROAD AHEAD

"In a year and a half to two years, you will see [the concepts developed at Executive TANG] being used in the fleet and rolled into the next Advanced Processing Build—which will be '15—and in the fleet in two years'," stated Commodore Parks during an interview following Executive TANG. His confidence in the outcome of the event and the future of the technology was evident as he believed Executive TANG had met the mark—fulfilling the mission to innovate concepts that can be built using today's

[302] IDEO, *Executive TANG Forum*.

available technology. “I think we…ended up with a [group of products] that [is] well within our technological means,” says CDR Steven Mongold, CO of the USS *Montpelier*.

There is a long process ahead in transforming concepts that currently exist only as artists’ renderings into black boxes ready for deployment. Beginning with Commodore Parks and the Submarine Tactical Requirements group that he chairs, the concepts will enter a period of review by senior leadership—as is standard practice for all technologies under development within the ARCI process. Fundamentally, that is what the results of the Executive TANG are: inputs to the rapid-COTS insertion program that have been sourced directly from the minds of the end users.

Regardless of the genesis of the input, whether from industry or from the Executive TANG Forum, the process of moving an idea from the conceptual phase to the waterfront begins with the STRG lending credence to the technology as both useful and necessary to the fleet of the future. Commodore Parks on the STRG’s role in moving these technologies forward:

> There is an active, I would say, *daily interaction* between the members of the STRG and the program managers who develop and field our software and our hardware on our combat systems, and that’s not an exaggeration. So, we’re joined at the hip in that process and it’s been very successful. We, as the developers, seek out industry to be able to make what we need, those proposals get proffered to the STRG for fleet input…the STRG *will provide feedback*, ‘Yes, this meets our desires and this is what we’re looking for in the fleet,’ or, ‘Hey, yeah, that’s close, but, you know, we’re really targeting this. What can you do for us here?’…The STRG, I think, is very strong in its opinion that we will *clearly articulate the gaps* that we want to close and *clearly articulate the desired capability* we want and then the rest of the organization…will decide on the priorities and what we can and cannot do from a modernization standpoint.[303]

As the Commodore alludes, though the Submarine Tactical Requirements Group plays a critical role in acting as the mouthpiece for the needs of the fleet, it is not solely their determinations that result in procurement. Rather, it requires the agreement of multiple areas within the larger Submarine Force, and, ultimately, the acquisition professionals at Naval Sea Systems Command who have a mandate to produce actionable

[303] Commodore Vern Parks, interview by Kevin Johnston, October 10, 2013.

enhancements for the fleet. Scott Tupper, who interacts regularly with the acquisitions community in his capacity on the staff of DEVRON-12, offers the following, "For [Pete Scala of NAVSEA], if we do this event that he paid to sponsor and he comes out the back end and he doesn't have anything that he can go build, well, that's a problem for him and that becomes a problem for us, because now we've lost the ability to do future events."[304]

Fortunately, Scott Tupper's concerns appear alleviated, at least for now, as the reaction to the Executive TANG concepts has largely been positive. Andy Leal of Lockheed Martin enthusiastically predicts success for a few of the Executive TANG concepts, "I am pretty sure [acquisitions] is going to latch on and put out Automated Solutions Development…because that is definitely where [they] have a lot of people with a lot of expertise…I would hope that [they] could take that A.I.M. concept and run with it because that was really easy to implement and there was a lot of people excited about that."[305]

1. The Future

As the Executive TANG concepts are making their way through the acquisitions process, decisions will soon be made as to which will make the cut to be included in future APBs and TIs. For the stakeholders and facilitators who created the TANG initiative, consideration can now be given to focusing on the future and to what extent design thinking may become a part of the submarine culture. A few months after the Forum was complete, one participant offered his thoughts:

> There is certainly value in exposing people to this process. Around the nuclear community, the nature of our training is so procedurally driven it can inhibit innovation. This is added value in the community—spreading better brainstorming and innovation techniques to the larger Navy. What the TANG Forum teaches is valuable but the Forums themselves aren't hitting the mark—they need to cast a wider net to spread these techniques throughout the fleet.[306]

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[304] Scott Tupper, interview by Robert Featherstone, October 9, 2013.

[305] Andy Leal, interview by Robert Featherstone, October 25, 2013.

[306] Commander Steven Mongold, interview by Robert Featherstone, December 11, 2013.

This quote is descriptive of a central theme that was often repeated after the Forum concluded. There is strong desire among many for design thinking to become part of the daily operation of the Submarine Force. To be used as another tool among many to solve the small, seemingly mundane problems that vex even the most experienced submariners. Scott Tupper understands this desire, suggesting that one of the ancillary benefits of continuing to sponsor design thinking events like Executive TANG is the continued education of submarine force personnel to the power of alternative problem solving methods:

> [The] value in first TANG was they tapped the right audience to address sonar problems and then sent 27 sailors back to the fleet caring more about the submarine community and solving problems therein. For Exec-TANG we introduced a bunch of senior submariners to a new process for solving problems. The IDEO process of brainstorming and prototyping leads to better solutions to problems. This is a huge side benefit of the Exec-TANG—teaching a bunch of senior guys a new way to solve problems.[307]

It would appear that word is indeed spreading, right to the top of the Force. Less than 2 months after the conclusion of Executive TANG, Josh Smith relayed the following account of a submarine CO's interaction with the Commander of the Submarine Force:

> Admiral Richardson [spoke] to CDR Steve Mongold of the Montpelier…[when he] took a tour of his boat and Admiral Richardson asked, 'Hey, so I heard you just got back from Executive TANG, I want you to send me an e-mail with your perspective of what that was like.' So, the sheer fact that those types of discussions are…happening, yeah, it's great to have that and it's great to get more people exposed to this and excited about it.[308]

Through positive exposure at the top echelons of Navy leadership, it seems the future is bright for the TANG initiative and the role of design thinking in the fleet. Participants and facilitators echo those sentiments:

CDR Kurt Balagna:

> The knowledge is out there. I think it's definitely a fruitful thing and I think TANGs will continue in different forms, like the Commodore

[307] Scott Tupper, interview by Robert Featherstone, October 9, 2013.

[308] Josh Smith, interview by Robert Featherstone, October 25, 2013.

> mentioned, I think this will be a continual process to evolve a certain area of the submarine and beyond.[309]

MCPON (ret.) Rick West:

> I thought it was a very interactive event—360-degree interactive. From the lowest individual that attended both the TANG and Executive TANG, their voice was heard and their input was considered just the same as the most senior…that creates synergy and buy-in. I think that's powerful.[310]

Andy Leal:

> I definitely think it was worthwhile because it is important to capture the perspective of the guys that have just reached command or been in command because you always hope that those are the ones that can step back just a little bit from the [knob] turning and so forth or the grunt work down at the deck plates to figure out what the big picture is going to be. I think some of the concepts that really came out emphasized that.[311]

The Executive TANG and its preceding Forums offered the Submarine Force an opportunity to try its hand at a completely new, paradigm-shattering method of technological innovation. A method focused on the needs and desires of the end user and centered on human interaction vice the dictated requirements that dominate other arenas.

TANG facilitators of the future have a challenging task in front of them, engendering the creative response of the Navy's greatest asset—its people. Regardless of rank, experience, background, or education level, TANG Forums and design thinking offer a method by which input from the average fleet operator and commander can be injected directly into the developmental process. "What I'm seeing [with] TANG is a shift in the mindset of how we do business," says MCPON West, "I think when you have something that can really make such a positive change in such a quick way it should really be pushed as a way to operate. I know you have to be careful…but I think it makes such a positive impact at the operational level. [These] are the cool ways, which our sailors will embrace, of bringing innovation to the forefront and continue to move the

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[309] Commander Kurt Balagna, interview by Robert Featherstone, September 10, 2013.

[310] Master Chief Petty Officer of the Navy (ret.) Rick West, interview by Kevin Johnston, January 11, 2014.

[311] Andy Leal, interview by Robert Featherstone, September 10, 2013.

Navy forward." He further adds, "It is my hope that we don't just let TANG be a 'flash in the pan'…hopefully we will not drag this thing [the current acquisition life cycle] out for three, four, five years. Technology is moving…our Navy is moving…"[312]

While the future of the concepts from Executive TANG may be uncertain, the realities of the ever-changing world in which the U.S. Submarine Force must operate remain constant. As the Force looks toward the future, assessing new threats and adversaries, events such as the Executive TANG Forum appear to have a found a place in the ongoing process of innovation.

[312] Master Chief Petty Officer of the Navy (ret.) Rick West, interview by Kevin Johnston, January 11, 2014.

IV. ANALYSIS OF FINDINGS

A. INTRODUCTION

In this chapter, the Executive TANG case study will be analyzed through the lenses of organizational change management and design thinking. Parallels will be articulated between characteristics of the TANG initiative (both Original and Executive TANG Forums) and both traditional and contemporary views of change management. This holistic analysis will lead to conclusions regarding the benefits of utilizing a participative, design thinking process to implement change within the DOD.

B. CHANGE MANAGEMENT

The Executive TANG case study presents a palpable opportunity to study organizational change management. This change effort is especially useful as it takes place in the DOD setting, an environment that is greatly lacking documented change efforts relating to technological innovation. Furthermore, the Executive TANG Forum provides a unique occasion in which to apply concepts of both traditional and contemporary change theory to both the micro-level change effort, conduct of the Executive TANG, and macro-level change effort, bringing design thinking to the submarine force.

1. The Leader as a Sense-maker

As discussed in the literature review, new requirements or changes to organizational context will always require action from leadership. Traditionally, proper action taken by leadership has been envisioned to be of the direct control variety. This would typically include the leader developing a vision of the desired end state, mapping a strategy to move in that direction, then *personally* executing the plan with precision and attention to detail. In the hierarchically-structured, machine bureaucracy that describes the submarine community and the military in general, these highly directive, authoritarian leadership styles and methods are typically rewarded as a leader is generally expected to exert direct command and control over the members of his unit. After all, the change of

command between commanding officers is a *transfer of total responsibility, authority and accountability* from one individual to another. The CO is responsible for everything that happens or fails to happen within their unit—the easiest way to manage that, traditionally, has been to exert direct control.

This type of leadership, however, may not be appropriate for organizations that are facing emergent challenges to the status quo. During these times, it may be more appropriate for the leader to function as a sense-maker, providing insight and guidance to their followers rather than tight control. This view is firmly rooted in the belief that good ideas bubble up from below and require leadership to contextualize good ideas rather than develop them in a singular fashion. It also allows organizations to take advantage of many viewpoints and/or ideas within an organization instead of just one. In order to accomplish this, leaders must let go of the desire to actively control the future and learn to view uncertainty and change as unavoidable opportunities to promote creativity and innovation among their team members.[313]

The idea to conduct the Original TANG, with junior officers and enlisted men, came from a white paper written by Josh Smith. In response to this revolutionary idea, Commodore Merz, then the commanding officer of DEVRON-12, immediately acknowledged the goodness in Smith's idea, but wanted to include more senior officers to get a broader perspective. Smith, however, articulated his reasons for wanting to do the Original TANG with more junior personnel and Commodore Merz accepted this. In this situation, Commodore Merz, instead of acting in the traditional "Do as I say" authoritarian leadership sense, instead acted as a sense-maker, providing insight and suggestion rather than tight control.

After the success of the Original TANG, Smith and his facilitation team expressed desire to conduct a follow-on TANG in short order. Upon hearing this, Commodore Merz acknowledged that it was a successful event and was of the same opinion as Smith—DEVRON-12 should facilitate another TANG. Merz recommended that the follow-on TANG use current and post-command submarine commanding officers to explore

[313] Plowman, Baker, Beck, Kulkarni, Solansky, and Travis, "Radical Change Accidentally," 540.

command-related issues. Josh Smith and the staff of DEVRON-12 agreed—the Executive TANG was born.

Shortly after inception of the Executive TANG, Commodore Merz turned over to Commodore Parks. As the new commanding officer of DEVRON-12, Commodore Parks excelled as a sense-maker as well. During the planning and execution of Executive TANG, Parks allowed Josh Smith, the staff of DEVRON-12, and the team from IDEO to lead the all efforts. In response, he made sense of those efforts and used the power of language to give support to them. During the actual conduct of the Forum, Josh Smith and IDEO made multiple improvisational pivots to alter the events of Forum (e.g., inserting Tech Expo personnel into brainstorming, using junior officers to provide constructive feedback to participants, having participants act out skits in multiple scenarios for each of their concepts, and so on). During these rapid changes, Commodore Parks was able to *trust* the abilities of the Forum facilitators and instead of exerting control over them, allowed them room to maneuver. He then provided overall meaning to the situation by using context-appropriate language during his multiple addresses to the Forum—publically supporting the actions of Josh Smith and the Executive TANG facilitation team.

2. Change Agent as an Embedded Actor and External Force

Traditional change theory holds the notion that organizational change must be prompted by an external force, usually in the form of an external actor. Whether the organization is a large bank or a unit within the DOD, successful large-scale organizational change is almost always prompted by a new actor coming to the organization. Despite this traditional view, some contemporary change theorists such as Trish Reay, Karen Golden-Biddle, and Kathy Germann combat this notion, and instead posit that change can be prompted by an embedded actor within an organization.

The change agent with respect to the TANG Forum (both the Original TANG and the Executive TANG) is undoubtedly Josh Smith. His role, however, can be viewed as both an embedded actor *and* an external force. Smith attended the U.S. Naval Academy and then served as a junior officer in the prestigious nuclear submarine community,

earning the rank of Lieutenant before exiting military service for a job with the Johns Hopkins Applied Physics Lab. Upon reaching his new position, Josh published his white paper. The idea to do the Original TANG came from an external force in that Josh Smith was outside of the Navy when he published the paper. One could also view him, however, as an embedded actor given the short time between exiting military service and when the paper was published, as well as the intimate knowledge of the submarine community and issues within that was required to have the insight to actually write a credible white paper. In essence, Smith timed his effort perfectly. He was able to capitalize on his ephemeral knowledge of the nuclear submarine community by quickly writing and publishing his white paper shortly after exiting the service while also being part of a separate, external organization that was not directly under the control of submarine community leadership.

3. Progression of Change Efforts

a. Pace

With regard to pace of change, the TANG initiative as a whole falls more in line with contemporary change theory. John Kotter argued that the number one error in implementing organizational change is not developing a great enough sense of urgency.[314] Traditional theory recommends rapid action in order to gain momentum and overcome any possible resistors to change. Some contemporary change theorists such as John Amis, Trevor Slack, and C.R. Hinings, however, suggest that *rapid change alone will not bring about successful results* and may actually prove detrimental as the shock of wholesale rapid change may paralyze an organization. Instead, they suggest *targeted change to high-impact functions, implemented rapidly, followed by a period of sedation* to allow the changes to take hold and the organization to adjust to new processes and relationships.[315]

When looked at holistically, the TANG initiative falls in line with the findings of Amis et al.—rapid change to high-impact functions followed by a slow-down period for

[314] John Kotter, *Leading Change*, 21.

[315] Amis, Slack, and Hinings, "The Pace, Sequence, and Linearity of Radical Change," 15.

change to solidify—a model of "fits and starts." Prior to the Original TANG, Josh Smith articulated to Commodore Merz that the first TANG needed to be completed with junior personnel, a high-impact group of actors within the submarine community that actually *performs* the work on a submarine. When the original TANG was commencing, the pace of change was rapid. After the event finished, however, the pace slowed down as the products of the workshop progressed through the defense acquisition pipeline. During this slower period, a few small-scale examples emerged throughout the submarine fleet of junior sailors using design thinking to solve real-world problems aboard the ship. Almost two years after the completion of the Original TANG, the Executive TANG commenced (Original TANG completed in November of 2011, Executive TANG commenced in September of 2013)—this started another rapid period of change where mid-level leaders in the submarine community actively learned a new process for solving problems and aggressively developed new technological solutions to improve command effectiveness. After completion of the Executive TANG, another sedation period followed, once again allowing for ideas to meander through the defense acquisition system. Overall, a holistic look at the macro-level change effort through micro-level TANGs suggests alignment with contemporary change theory—pace of change does not occur rapidly but rather in a fashion of "fits and starts."

b. Sequence and Linearity

Traditional change theory holds that change is a linear process, occurring at relatively constant rate and affecting an organization in a pre-determined manner. The sequence is also very procedural—Lewin's "Unfreeze, Change, Refreeze" model as well as Kotter's 8-step archetype both support the traditional views of sequence and linearity. Other contemporary change theorists, however, posit that *change is occurring within different parts of an organization at different rates* and with varying success—change is non-linear and incremental.

The TANG initiative falls more in line with the contemporary view of sequence and linearity. After the execution of the Original TANG, examples began almost immediately popping up around the fleet of sailors using design thinking to solve real

world problems. Five months after the completion of the Executive TANG, however, the researchers were unable to identify any tangible evidence of the design thinking process being utilized by Forum participants. Furthermore, the follow-on action to the Executive TANG was not defined prior to the actual commencement of the workshop. After the Executive TANG concluded and participants were allowed to provide feedback on the forum, one participant suggested to "get a bunch of enlisted guys together to try to make life in port better." In response to this suggestion, Josh Smith and Commodore Parks expressed interest in exploring this topic for the next TANG, supporting the notion that there is no set procedural plan in terms of the overall change effort. Instead, the submarine community appears to be meandering through a macro-level change effort, leaving plenty of room to adjust their actions along the way, suggesting a lack of linearity and an unknown sequence.

c. Small Wins

Both traditional change theory and contemporary change theory recognize the importance of realizing the cumulative effect of small wins. These small wins offer opportunities to motivate and sustain persistent, long-term change. During this long-term change, small wins can be small enough to commence without attracting the attention of powerful resistors but large enough to create momentum for change agents.

The TANG initiative has achieved at least three small wins to date. The successful completion of the Original TANG was the first small win, where change agents targeted a relatively small group of junior officers and enlisted personnel. This effort allowed the agents to harness the creativity of young people while also proving the TANG concept with a captive audience. The execution of the Executive TANG was another small win within the macro-level change effort as mid-level officers were targeted. This specific effort allowed focus on higher-level issues while increasing the amount of buy-in for the overall effort, as field grade officers from more than 20 different submarines/shore commands were represented. In between these two major TANGs was another small win that has not received as much publicity. A separate TANG occurred in between Original TANG and Executive TANG called the Australia TANG. During this effort, submariners

in the Australian Navy participated in a TANG-like event focusing on the needs of the Australian submarine fleet. This effort gave the TANG initiative some international exposure and another small win. While no one knows if the TANG initiative will lead to macro-level organizational change in the submarine community or the U.S. Navy as a whole, both traditional and contemporary change theory emphasize the importance of small wins in the greater change effort.

4. Overcoming Skeptics

During one of the Executive TANG Forum group feedback sessions, one of the participants jokingly remarked "Like a good nuke, I hate change but I really like what you did with this." While this individual made this remark in jest, undoubtedly one of the major barriers that a change effort must overcome is possible resistors. According to Paul Lawrence, in his article *How to Deal with Resistance to Change*, resistance may take a number of forms including persistent reduction in output, increase in the number of "quits," and/or request for transfer, chronic quarrels, sullen hostility, wildcat or slowdown strikes, and the expression of a lot of pseudo-logical reasons why the change will not work.[316] While many of these are not applicable to a military organization due to cultural emphasis on discipline and chain of command, the expression of why the change will not work, especially behind closed doors, would likely occur and could derail a change effort if it gained enough support.

During the initial stages of the Executive TANG Forum, multiple participants expressed initial skepticism to the processes used and a defensive posture towards perceived threats to established procedures within the submarine community. While most of these occurrences could be viewed as healthy skepticism, there were a few individuals, mostly those that represented the more senior pool of officers at the Forum, who seemed outright resistant at first—demonstrated by sarcastic remarks about the process being taught or through the putting down of participants energetically attempting to learn and contribute. This resistance and aforementioned skepticism, however, was overcome

[316] Paul Lawrence, "How to Deal with Resistance to Change," *Harvard Business Review*, May/June 1954, 425–426.

through the team momentum formed in each of the groups—accomplished by expert facilitators skilled in managing complex group dynamics.

When approaching resistance to the TANG initiative as a whole, it can be assumed that there are pockets of resistance within the submarine and acquisitions communities. Individuals within these communities may be embedded in the successes of the current requirements-based development process. Overcoming this resistance may be achieved as the TANG initiative progresses, further exposing community leaders to the design process. As design thinking is socialized among key stakeholders, the value of resistant opinions will likely diminish. Moreover, as the technologies developed through the TANG process become accepted within the fleet, the validity of design as a developmental process will be indisputable.

5. Implications of Change Management

After studying the planning and execution of the Executive TANG Forum in addition to the overall TANG initiative, parallels have been drawn to both traditional and contemporary theories of change. In terms of leadership, the key leader actions of the TANG initiative fall mainly in-line with contemporary change theory, which views the leader as a sense-maker, using context-appropriate language to give sense to situations. When exclusively exploring the primary change agent, Josh Smith, however, his change force can be viewed as both external and embedded given his external place outside the submarine community and his embedded knowledge from recent years spent in the community. When exploring pace, sequence, and linearity, the characteristics of the overall TANG initiative fall in line with contemporary theory, which states that change happens through a mix of rapid and slow pace, and in a non-linear and incremental manner instead of a procedural way. Despite these alignments with contemporary theory, one of the most important aspects of the TANG change initiative, the accumulation of small wins, aligns with both traditional and contemporary change theory in which each emphasize the importance of this action to overcome sources of resistance and ensure the long-term success of a change effort.

Regardless of the theory that explains the actions within the TANG initiative, the Executive TANG case study serves to highlight many important aspects of change. Capturing the details of this change initiative will contribute to the DOD's seemingly under-developed rolodex of case studies, enabling Defense leadership to learn from this event to aid in future technological change implementations.

C. DESIGN THINKING

The previous section summarized the relationship between the Executive TANG case study and various theories of change management. As articulated in the literature review, however, change management only increases the chances of *successfully implementing* a change effort; it does not help in determining *what the change should be*. This is where design thinking is necessary. In this section, the relationship between the Executive TANG case study and design thinking will be explored.

1. A Truly Wicked Problem

Exploring command-level issues in the submarine force is without question a wicked problem. The catalyst (problem) driving the Executive TANG Forum satisfied multiple criteria required for a problem to be designated wicked, when only one criterion would have been sufficient. First and foremost, the overarching problem addressed at the Executive TANG Forum, *improving command effectiveness,* is complex and deeply ambiguous. Since there is no tangible measurement tool used for determining how well a CO is doing, the effectiveness of anyone in that job is subjective and vague. Furthermore, this task of improving effectiveness of the command is far reaching and could include exploring the enablement of subordinates, effective information sharing, streamlining processes for dealing with the crew, optimally synthesizing inputs from multiple disparate systems, making sound and timely decisions, leveraging new technologies, and the list goes on and on. Since the CO is ultimately responsible for anything that happens or fails to happen under his watch, improving the effectiveness of his command is truly complex and ambiguous.

The wicked nature of this problem is exacerbated by the seemingly long list of stakeholders, another criterion of a wicked problem. When looking at improving

submarine command effectiveness, the unit responsible for training the submarine fleet, DEVRON-12, is a key stakeholder along with all of the acquisition professionals who manage the procurement and upgrading of all systems onboard the submarine—this includes the head for Integrated Warfare Systems 5 (IWS 5), the Submarine Acoustic Systems Program Office (PMS 401), the Submarine Combat System Program Office (PMS 425), and the Submarine Sensor Systems Program Office (PMS 435). In addition to these acquisition professionals, the Commander of Submarine Forces and the Director of Naval Nuclear Propulsion also have a stake in the Executive TANG. Taking into account all of the opinions, ideas, and agendas of these powerful stakeholders makes *improving command effectiveness* much more difficult than it may seem at the surface.

2. Contextual Observation

Contextual observation is nothing more than actually *seeing* what you are exploring within its natural habitat (context). When individuals focus exclusively on quantitative and sometimes qualitative *data,* a problem that has plagued the last 20 years due to drastic improvement in computing power/capability, it can become very difficult to notice a solution to a problem that might be right in front of them because the data has no emotional content—it is just data.[317] Giving people the tool of *contextual observation*, a different way of seeing that reality, however, helps them to address the problem.[318]

When IDEO was initially hired to facilitate the Executive TANG Forum, one of the first actions they completed was their ethnographic user research, consisting primarily of user interviews and observation sessions. A major component to this task was actually riding a submarine to explore what command is all about. For the civilian designers at IDEO to truly understand the nature of this wicked problem they needed to embed themselves in the everyday life of that community and observe actors in the context of their day-to-day routines. Had they not done this and instead strictly relied on pre-existing data, it would have been very difficult to make an emotional connection with the problem at hand, a critical part to approaching a problem with a design thinking mindset.

[317] Boland and Collopy, *Managing as Designing*, 190.

[318] Ibid.

3. Rapid Prototyping

Participants at the Executive TANG Forum utilized rapid prototyping to develop solutions to the overarching problem addressed at the forum. While the challenge of improving command effectiveness is complex and ambiguous, by rapidly constructing physical representations of an idea, participants were able to explore hunches or distant ideas that helped to advance their understanding of the problem and be mindful of lots of possibilities. All the while, minimal resources were actually committed to the effort (both time and material) while participants explored. Rapid prototyping also helped participants receive stake holder feedback while constructing the tangible representations of their ideas.

The DOD uses the systems engineering process to guide the design and management of complex engineering projects. This process focuses on work-processes, optimization methods, and risk management tools. One of the major drawbacks to the systems engineering process is the large expenditure of time and money. Given that the DOD is entering an interwar period plagued with decreased procurement dollars, adopting a rapid prototyping mindset across the Defense Department would benefit the force in both tangible (money and time) as well as intangible ways (improvement of problem solving skills and increase of creative capacity).

4. Balance between Exploration and Exploitation

The DOD, much like various industries in the corporate world, has focused heavily on exploitation, the action of making use of and benefitting from *existing* resources. Every tangible item, however, can only be exploited so far—once you reach a certain point, exploration must take place to generate *new* resources or ideas. The most successful organizations are able to balance between exploitation and exploration. Similar to the inventory control problem where *optimally* a warehouse would focus on calculating reorder points, lot sizes, and minimizing holding costs (exploitation) while also rethinking the design of production processes, relationships with suppliers, and use of information systems (exploration), the DOD must also balance between the two.

The Executive TANG Forum focused heavily on exploration. While existing technologies such as iPads and multi-touch displays were exploited to a certain degree, much of the activity was in the area of exploring new ways to make the CO more effective. Over a relatively short period of time (three full days), eight concepts were developed, each uniquely addressing the identified needs of those who had developed the concept. The eight proposed solutions spanned the range of the problem space, some addressing technical solutions to tactical problems, others attempting to provide greater detail on personnel, training, and readiness concerns. The creation of these ideas was due to the Forum's heavy focus on *what currently does not exist* (exploration) while in some cases exploiting key technologies already in existence to support the developing concept, achieving a nice balance between exploration and exploitation.

5. Converge and Diverge

Design thinking is an iterative process of convergence and divergence. In the U.S. military in general and the Navy's submarine force specifically, convergence around a single idea and/or leader is usually greatly emphasized over divergence to generate new ideas. The Executive TANG Forum, however, focused equally on both activities as participants meandered through the problem. At the Forum, participants:

- Diverged to develop problem questions (HMWs) that could deconstruct the overall problem (improving command effectiveness)
- Converged to vote on the best HMWs
- Diverged to begin brainstorming possible solutions to the HMWs
- Converged to share concepts from brainstorming
- Diverged to begin rapid prototyping
- Converged to complete concept reviews and receive group feedback on prototypes
- Diverged to continue refinement and development of concepts
- Converged to perform final group share-back in skit form.

This iterative process of divergence to develop and explore and convergence to vote and decide may seem too time consuming and repetitive to the outsider. Using this process, however, allowed Executive TANG participants to focus specifically on the

generation of new ideas during the divergence phase, an area often overlooked in military planning—which typically involves a set amount of time to *frame the problem* (identify constraints and restraints, planning assumptions, outlining enemy and friendly capabilities, etc.) followed by generation of courses of action, and then subsequent "war gaming" of those actions. Some criticize this process because groups of planners tend to move to solution generation (course of action development) too quickly without adequately understanding the problem. Realizing that time is always a constraint, moving to an iterative process may help alleviate this—instead of flowing from one step to another in a linear manner, groups could alternate between convergence and divergence without fear of having to go back to explore emerging nuances, as would be expected in a truly iterative process.

6. Implications of Design Thinking

The Executive TANG case study provides an excellent source of material for exploring the benefits of design thinking in the DOD. *Improving command effectiveness* is truly a wicked problem, a type of problem set that will continue to dominate the problem-solving space. While this may seem daunting at first, having a tool like the Executive TANG case study will enable DOD leaders to learn about the tools of contextual observation and rapid prototyping that can help to address wicked problems. Furthermore, understanding the balance between exploitation and exploration will help leaders realize adequate focus must be placed on *creating what does not exist* while being mindful of exploiting what currently does—and the use of alternating cycles of convergence and divergence can facilitate the military planning process.

D. INTRODUCING INNOVATION

The Executive TANG case study demonstrates the *complementary* nature of organizational change management and design thinking. While change management increases the chances of successful *execution* of a change effort, design thinking provides a method to determine *what the change should be*, an essential activity in an organization seeking to innovate. While some may think design thinking is inapplicable to the military due to emphasis on rank, chain of command and discipline, the human-centered nature of

design allows its application to any human activity. Design thinking is more apt to create a solution that is more widely accepted given the participative nature of the methodology.

Upon analysis of the Executive TANG Forum Case Study, the following methodology is provided summarizing the introduction of innovation, embodied by the TANG initiative, into the hierarchical organization of the U.S. Navy's Submarine Force:

- An actor external to the organization develops an idea to address an innovative gap.
- In order to have credibility, the external actor should possess intimate knowledge of the organization requiring change.
- The articulation of the change effort, either verbal or written, must then reach a key organizational stake holder. Ideally, the stake holder would have a track record of demonstrating a willingness to take provocative action.
- Begin implementing the overall change initiative among a non-indoctrinated audience (junior personnel). Upon completion, encourage follow-on action by participants through engagement with other members of the organization.
- After achieving a small win through initial small-scale implementation, allow leaders to use the power of language to make sense of the change effort to the greater organization.
- Ensure the output of the change initiative is validated through use and acceptance, demonstrating the change's value.
- Harness the sedation period while buzz forms around the greater change effort.
- Begin planning the next stage of the change initiative, which should ideally engage higher-level individuals within the organization.
- Upon achieving the second small win, harness the sedation period while buzz forms on a larger scale as higher-level individuals spread the word.
- Plan additional events to continue advancing the effort to the greater organization.

E. CONCLUSION

In this chapter, the Executive TANG case study was analyzed through the lenses of organizational change management and design thinking. Parallels were articulated between characteristics of the TANG initiative and both traditional and contemporary views of change management. The complementary nature of design thinking as an

adjunct to change management was articulated as design thinking provides the method for determining *what the change should be* while change management increases the chance of successful *implementation*. The benefits of utilizing a participative, design thinking process to implement change within the DOD include a focus on the actual needs of end users to enhance usability and adoption, increased creativity with decreased expenditures (time and money) through rapid prototyping, as well as the introduction of an iterative process, demonstrating that a linear process does not always yield the best results.

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V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This research offers a glimpse into the specific events surrounding the Executive TANG Forum as a demonstration of design thinking in action. The events are representative of an alternative method of problem solving that may prove increasingly important as the DOD begins to grapple with innovation under highly-impactful fiscal constraints. As the resources of the past tighten and affect the processes of the future, organizations will be forced to adapt and change. Traditional paradigms of change management emphasize decisive leadership—the visionary guidance of an experienced leader who has been endowed with "the answers" obtained through vast experience. This paradigm is a perfect fit for the type of machine bureaucracies that flourished during the 20th century but may not offer the best possible results for a modern organization comprised of educated, creative professionals.

This case study also presents an alternative to traditional views of change management. In this manner, design thinking is both an aide to conceptual development and a method of introducing change. With its focus on form as well as function, design thinking offers a collaborative method by which technology and the processes it enables can be enhanced to provide a superior user experience that fundamentally alters established practice. During the Executive TANG Forum, highly experienced senior leaders within the submarine community collaborated to develop innovative concepts that exploit technology while exploring improvements to their core processes. Their efforts go deeper than simply making better or more capable technology, as the fundamental problem before the Forum was improving command effectiveness. In this manner, the use of design thinking was as much about producing new technology as it was about producing new processes—altering the traditional practices of the commanding officer and bringing change to the Submarine Force.

Further, this case examines an organization experimenting with new cultural values. The Executive TANG represents an attempt by some within the Submarine Force

to expand the toolkit available to leaders as they attempt to solve the problems impacting their daily lives and missions. The design thinking process brings to bear on a problem the full creative power of the collective while simultaneously emphasizing that the best ideas are the result of insights gained through user experience. Traditional hierarchical practice tends to over-emphasize the value of the ideas generated by senior leadership at the expense of those generated by end-users. Initiatives such as TANG may potentially bridge the gap between the desires of leadership and the needs of the end user, promoting active involvement in the development process by users and improving adoption rates once new technology is introduced.

The long-lasting goal of this research is production of a real-world case study that may be used to analyze the design method as an alternative to the traditional requirements-based development process. Though the requirements-based process has its merits it also erects significant barriers to the free-flow of creativity in the development of new technology. Just as contemporary change theory emphasizes the value of ideas that "bubble up" from below, so too should the emphasis on design thinking as a valuable enhancement to the process of developing technology within the DOD. Senior leadership, acquisitions professionals, scientists, engineers, and visionaries all undoubtedly have fantastic ideas. End-users do as well. Understanding the value of harnessing the creative power of the diverse input from all fields, including the average user, will greatly enhance the ability of DOD to develop technology that enables their personnel to achieve greater success.

B. RECOMMENDATIONS FOR FUTURE RESEARCH

As this research comes to a close, the authors are aware of two similar design thinking efforts underway or in the planning stages. The first is a continuation of the TANG series as it expands into the Navy's surface ship fleet. Tentatively called the "Surface TANG," this event holds the potential for researchers to continue to develop an understanding of the applicability of design thinking in DOD settings while examining its use among a whole new community with different cultural values than the submarine community examined herein. An analysis of the cultural similarities and differences

between the submarine and surface communities as they relate to willingness to employ design methods may yield greater understanding as to the dynamics of design in a military organization and what elements of the process resonate with the military designer.

The second design-related area of inquiry is also found in the Navy's surface fleet. There is an ongoing design and mutual collaboration initiative being conducted aboard the USS *Benfold* (DDG-65) that has garnered positive attention from leadership. Developed from the idea of a junior officer aboard the ship and with sponsorship from the commanding officer, the *Benfold* holds periodical innovation events in which command personnel are asked to develop innovative solutions to the problems that plague them. Studying this initiative may offer another opportunity to observe the actions of change agents and leadership in creating an environment in which alternative problem solving methods could flourish.

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APPENDIX A. U.S. NAVY SUBMARINE SPECIFICATIONS

U.S. Navy Fact Sheet

Attack Submarines - SSN

Description
Attack submarines are designed to seek and destroy enemy submarines and surface ships; project power ashore with Tomahawk cruise missiles and Special Operation Forces; carry out Intelligence, Surveillance, and Reconnaissance (ISR) missions; support battle group operations; and engage in mine warfare.

Background
With the number of foreign diesel-electric/air-independent propulsion submarines increasing yearly, the United States Submarine Force relies on its technological superiority and the speed, endurance, mobility, stealth, and payload afforded by nuclear power to retain its preeminence in the undersea battlespace.

The Navy has three classes of SSNs in service. Los Angeles (SSN 688)-class submarines are the backbone of the submarine force with 41 now in commission. Thirty Los Angeles-class SSNs are equipped with 12 Vertical Launch System tubes for firing Tomahawk cruise missiles.

The Navy also has three Seawolf-class submarines. Commissioned on July 19, 1997, USS Seawolf (SSN 21) is exceptionally quiet, fast, well-armed, and equipped with advanced sensors. Though lacking Vertical Launch Systems, the Seawolf class has eight torpedo tubes and can hold up to 50 weapons in its torpedo room. The third ship of the class, USS Jimmy Carter (SSN 23), has a 100-foot hull extension called the multi-mission platform. This hull section provides for additional payloads to accommodate advanced technology used to carry out classified research and development and for enhanced warfighting capabilities.

The Navy is now building the next-generation attack submarine, the Virginia (SSN 774) class. The Virginia class has several innovations that significantly enhance its warfighting capabilities with an emphasis on littoral operations. Virginia class SSNs have a fly-by-wire ship control system that provides improved shallow-water ship handling. The class has special features to support special operation forces including a reconfigurable torpedo room that can accommodate a large number of special operation forces and all their equipment for prolonged deployments and future off-board payloads. The class also has a large lock-in/lock-out chamber for divers. In Virginia-class SSNs, traditional periscopes have been supplanted by two photonics masts that host visible and infrared digital cameras atop telescoping arms. With the removal of the barrel periscopes, the ship's control room has been moved down one deck and away from the hull's curvature, affording it more room and

an improved layout that provides the commanding officer with enhanced situational awareness. Additionally, through the extensive use of modular construction, open architecture, and commercial off-the-shelf components, the Virginia class is designed to remain state of the practice for its entire operational life through the rapid introduction of new systems and payloads.

As part of the Virginia-class' third, or Block III, contract, the Navy redesigned approximately 20 percent of the ship to reduce their acquisition costs. Most of the changes are found in the bow where the traditional, air-backed sonar sphere has been replaced with a water-backed Large Aperture Bow (LAB) array which reduces acquisition and life-cycle costs while providing enhanced passive detection capabilities. The new bow also replaces the 12 individual Vertical Launch System (VLS) tubes with two 87-inch Virginia Payload Tubes (VPTs), each capable of launching six Tomahawk cruise missiles. The VPTs simplify construction, reduce acquisition costs, and provide for more payload flexibility than the smaller VLS tubes due to their added volume.

Point Of Contact
Office of Corporate Communication (00D)
Naval Sea Systems Command
Washington, D.C. 20362

General Characteristics, *Virginia* class
Builder: General Dynamics Electric Boat Division and Huntington Ingalls Industries Inc. - Newport News Shipbuilding
Date Deployed: USS *Virginia* commissioned October 3, 2004
Propulsion: One nuclear reactor, one shaft
Length: 377 feet (114.8 meters)
Beam: 33 feet (10.0584 meters)
Displacement: Approximately 7,800 tons (7,925 metric tons) submerged
Speed: 25+ knots (28+ miles per hour, 46.3+ kph)
Crew: 132: 15 officers; 117 enlisted
Armament: *Tomahawk* missiles, twelve VLS tubes, MK48 ADCAP torpedoes, four torpedo tubes
Ships:
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USS Virginia (SSN 774), Portsmouth, NH
USS Texas (SSN 775), Pearl Harbor, HI
USS Hawaii (SSN 776), Pearl Harbor, HI
USS North Carolina (SSN 777), Pearl Harbor, HI
USS New Hampshire (SSN 778), Groton, CT
USS New Mexico (SSN 779), Groton, CT
USS Missouri (SSN 780), Groton, CT
USS California (SSN 781), Groton, CT
USS Mississippi (SSN 782), Groton, CT
USS Minnesota (SSN 783), Norfolk, VA
North Dakota (SSN 784), No homeport - Construction began March 2009. Christened 2 November 2013.
John Warner (SSN 785), No homeport - Construction began March 2010
Illinois (SSN 786) - Construction began in March 2011.
Washington (SSN 787) - No homeport, construction began in September 2011
Colorado (SSN 788) - No homeport, construction began in March 2012.
Indiana (SSN 789) - No homeport, construction began September 2012.
South Dakota (SSN 790) - Under contract.
Delaware (SSN 791) - Under contract.

General Characteristics, *Seawolf* class

Builder: General Dynamics Electric Boat Division
Date Deployed: *USS Seawolf* commissioned July 19, 1997
Propulsion: One nuclear reactor, one shaft
Length: SSNs 21 and 22: 353 feet (107.6 meters)
SSN 23: 453 feet (138.07 meters)
Beam: 40 feet (12.2 meters)
Displacement: SSNs 21 and 22: 9,138 tons (9,284 metric tons) submerged;
SSN 23: 12,158 tons (12,353 metric tons) submerged
Speed: 25+ knots (28+ miles per hour, 46.3+ kph)
Crew: 140: 14 Officers; 126 Enlisted
Armament: *Tomahawk* missiles, MK48 torpedoes, eight torpedo tubes
Ships:
USS Seawolf (SSN 21), Bangor, WA
USS Connecticut (SSN 22), Bangor, WA
USS Jimmy Carter (SSN 23), Bangor, WA

General Characteristics, *Los Angeles* class
Builder: Newport News Shipbuilding Co.; General Dynamics Electric Boat Division
Date Deployed: Nov 13, 1976 *(USS Los Angeles)*
Propulsion: One nuclear reactor, one shaft
Length: 360 feet (109.73 meters)
Beam: 33 feet (10.06 meters)
Displacement: Approximately 6,900 tons (7011 metric tons) submerged
Speed: 25+ knots (28+ miles per hour, 46.3 +kph)
Crew: 16 Officers; 127 Enlisted
Armament: *Tomahawk* missiles, VLS tubes (SSN 719 and later), MK48 torpedoes, four torpedo tubes
Ships:
USS Los Angeles (SSN 688), Pearl Harbor, HI
USS Philadelphia (SSN 690), Groton, CT
USS Memphis (SSN 691), Portsmouth, NH
USS Bremerton (SSN 698), Pearl Harbor, HI
USS Jacksonville (SSN 699), Pearl Harbor, HI
USS Dallas (SSN 700), Groton, CT
USS La Jolla (SSN 701), Pearl Harbor, HI
USS City of Corpus Christi (SSN 705), Pearl Harbor, HI
USS Albuquerque (SSN 706), San Diego, CA
USS Portsmouth (SSN 707), San Diego, CA
USS Minneapolis-St. Paul (SSN 708), Pearl Harbor, HI
USS Hyman G. Rickover (SSN 709), Norfolk, VA
USS Augusta (SSN 710) - Decommissioned February 11, 2009
USS San Francisco (SSN 711), San Diego, CA
USS Houston (SSN 713), Pearl Harbor, HI
USS Norfolk (SSN 714), Norfolk, VA
USS Buffalo (SSN 715), Pearl Harbor, HI
USS Salt Lake City (SSN 716), San Diego, CA
USS Olympia (SSN 717), Pearl Harbor, HI
USS Honolulu (SSN 718), Pearl Harbor, HI
USS Providence (SSN 719), Groton, CT
USS Pittsburgh (SSN 720), Groton, CT
USS Chicago (SSN 721), Guam
USS Key West (SSN 722), Guam
USS Oklahoma City (SSN 723), Guam
USS Louisville (SSN 724), Pearl Harbor, HI
USS Helena (SSN 725), Norfolk, VA
USS Newport News (SSN 750), Norfolk, VA
USS San Juan (SSN 751), Groton, CT

USS Pasadena (SSN 752), San Diego, CA
USS Albany (SSN 753), Norfolk, VA
USS Topeka (SSN 754), Portsmouth, NH
USS Miami (SSN 755), Portsmouth, NH - Commenced inactivation September 27, 2013
USS Scranton (SSN 756), Norfolk, VA
USS Alexandria (SSN 757), Portsmouth, NH
USS Asheville (SSN 758), San Diego, CA
USS Jefferson City (SSN 759), San Diego, CA
USS Annapolis (SSN 760), Groton, CT
USS Springfield (SSN 761), Groton, CT
USS Columbus (SSN 762), Pearl Harbor, HI
USS Santa Fe (SSN 763), Pearl Harbor, HI
USS Boise (SSN 764), Norfolk, VA
USS Montpelier (SSN 765), Norfolk, VA
USS Charlotte (SSN 766), Pearl Harbor, HI
USS Hampton (SSN 767), San Diego, CA
USS Hartford (SSN 768), Groton, CT
USS Toledo (SSN 769), Groton, CT
USS Tucson (SSN 770), Pearl Harbor, HI
USS Columbia (SSN 771), Pearl Harbor, HI
USS Greeneville (SSN 772), Pearl Harbor, HI
USS Cheyenne (SSN 773), Pearl Harbor, HI

Last Update: 6 December 2013

Fleet Ballistic Missile Submarines - SSBN

Description
Since the 1960s, strategic deterrence has been the SSBN's sole mission, providing the United States with its most survivable and enduring nuclear strike capability.

Features
The Navy's ballistic missile submarines, often referred to as "boomers," serve as an undetectable launch platform for intercontinental missiles. They are designed specifically for stealth and the precise delivery of nuclear warheads.

The 14 *Ohio*-class SSBNs can carry up to 24 submarine-launched ballistic missiles (SLBMs) with multiple independently-targeted warheads. Under the New Strategic Arms Limitation Treaty, however, each submarine will have four of its missile tubes permanently deactivated in the coming years. The SSBN's strategic weapon is the Trident II D5 missile, which provides increased range and accuracy over the now out-of-service Trident I C4 missile.

SSBNs are specifically designed for extended deterrent patrols. To decrease the amount of time required for replenishment and maintenance, *Ohio*-class submarines have three large-diameter logistics hatches that allow sailors to rapidly transfer supply pallets, equipment replacement modules and machinery components thereby increasing their operational availability.

The *Ohio*-class design allows the submarines to operate for 15 or more years between major overhauls. On average, the submarines spend 77 days at sea followed by 35 days in-port for maintenance. Each SSBN has two crews, Blue and Gold, which alternate manning the submarines and taking them on patrol. This maximizes the SSBN's strategic availability, reduces the number of submarines required to meet strategic requirements, and allows for proper crew training, readiness, and morale.

Point Of Contact
Office of Corporate Communication
Naval Sea Systems Command
Office of Corporate Communications (SEA 00D)
Washington, D.C. 20376

General Characteristics, *Ohio* Class
Builder: General Dynamics Electric Boat Division.
Date Deployed: Nov. 11, 1981 (USS *Ohio*)
Propulsion: One nuclear reactor, one shaft.
Length: 560 feet (170.69 meters).
Beam: 42 feet (12.8 meters).
Displacement: 16,764 tons (17,033.03 metric tons) surfaced; 18,750 tons (19,000.1 metric tons) submerged.
Speed: 20+ knots (23+ miles per hour, 36.8+ kph).
Crew: 15 Officers, 140 Enlisted.
Armament: 24 tubes for Trident II submarine-launched ballistic missiles, MK48 torpedoes, four torpedo tubes.
Ships:
USS Henry M. Jackson (SSBN 730), Bangor, WA
USS Alabama (SSBN 731), Bangor, WA
USS Alaska (SSBN 732), Kings Bay, GA
USS Nevada (SSBN 733), Bangor, WA
USS Tennessee (SSBN 734), Kings Bay, GA
USS Pennsylvania (SSBN 735), Bangor, WA

USS West Virginia (SSBN 736), Portsmouth, VA
USS Kentucky (SSBN 737), Bangor, WA
USS Maryland (SSBN 738), Kings Bay, GA
USS Nebraska (SSBN 739), Bangor, WA
USS Rhode Island (SSBN 740), Kings Bay, GA
USS Maine (SSBN 741), Bangor, WA
USS Wyoming (SSBN 742), Kings Bay, GA
USS Louisiana (SSBN 743), Bangor, WA

Last Update: 6 December 2013

Guided Missile Submarines - SSGN

Description
Ohio-class guided-missile submarines (SSGN) provide the Navy with unprecedented strike and special operation mission capabilities from a stealthy, clandestine platform. Armed with tactical missiles and equipped with superior communications capabilities, SSGNs are capable of directly supporting Combatant Commander's strike and Special Operation Forces (SOF) requirements.

Background
The 1994 Nuclear Posture Review determined that the United States needed only 14 of its 18 SSBNs to meet the nation's strategic force needs. Therefore, the Navy decided to transform four Ohio-class submarines into conventional land attack and SOF platforms. This allowed the Navy to leverage existing submarine technology while at the same time expanding capability to meet the current and future needs of U.S. combatant commanders.

The SSGN Program Office refueled and converted four SSBNs into SSGNs in a little more than five years at a significantly lower cost and less time than building a new platform. USS *Ohio* (SSGN 726) entered the shipyard on Nov. 15, 2002, completed conversion in December 2005 and deployed for the first time in October 2007. USS *Florida* (SSGN 728) commenced its refueling and conversion in August 2003 and returned to the fleet in April 2006. USS *Michigan* (SSGN 727) started its shipyard availability in October 2004 and delivered in November 2006. USS *Georgia* (SSGN 729) completed conversion in December 2007.

The Navy entered into a unique partnership to bring the SSGN concept to fruition. All four submarines required an Engineered Refueling Overhaul (ERO) in addition to extensive conversion work. Puget Sound Naval Shipyard in Washington carried out the EROs for both *Ohio* and *Michigan* while Norfolk Naval Shipyard, located in Virginia, conducted *Florida's* and *Georgia's* refueling. The Navy awarded General Dynamics' Electric Boat the contract to convert the SSBNs into SSGNs with the company carrying out that work within the Naval Shipyards-the first time such collaboration had been conducted. This first-of-a-kind partnership has proved highly successful as the program finished on time and on cost.

Combined, the four SSGNs represent more than half of the Submarine Force's vertical launch payload capacity with each SSGN capable of carrying up to 154 Tomahawk land-attack cruise missiles. The missiles are loaded in seven-shot Multiple-All-Up-Round Canisters (MACs) in up to 22 missile tubes. These missile tubes can also accommodate additional stowage canisters for SOF equipment, food, and other consumables to extend the submarines' ability to remain forward deployed in support of combatant commander's tasking. The missile tubes are also able to accommodate future payloads such as new types of missiles, unmanned aerial vehicles, and unmanned undersea vehicles.

The SSGNs have the capacity to host up to 66 SOF personnel at a time. Additional berthing was installed in the missile compartment to accommodate the added personnel, and other measures have been taken to extend the amount of time that the SOF forces can spend deployed aboard the SSGNs. The two forward most missile tubes were permanently converted to lock-out chambers that allow clandestine insertion and retrieval of SOF personnel. Each lock-out chamber can also accommodate a Dry Deck Shelter (DDS), enhancing the SSGNs' SOF capabilities.

During conversion, each SSGN received the Common Submarine Radio Room and two High-Data-Rate antennas for significantly enhanced communication capabilities. These additions allow each SSGN to serve as a forward-deployed, clandestine Small Combatant Joint Command Center.

The SSGN is a key element of the Navy's future fighting force. With its tremendous payload capacity, dual crew deployment concept, and inherent stealth, each SSGN brings mission flexibility and enhanced capabilities to the warfighter.

Point Of Contact
Office of Corporate Communication (SEA 00D)
Naval Sea Systems Command
Washington, D.C. 20376

General Characteristics, *Ohio* Class
Builder: General Dynamics Electric Boat Division.
Propulsion: One nuclear reactor, one shaft.
Length: 560 feet (170.69 meters).
Beam: 42 feet (12.8 meters).
Displacement: 16,764 tons (17,033.03 metric tons) surfaced; 18,750 tons (19,000.1 metric tons) submerged.
Speed: 20+ knots (23+ miles per hour, 36.8+ kph).
Crew: 15 Officers, 144 Enlisted.
Armament: Up to 154 Tomahawk missiles, Mk48 torpedoes; 4 torpedo tubes.
Ships:
USS Ohio (SSGN 726), Bangor, WA
USS Michigan (SSGN 727), Bangor, WA
USS Florida (SSGN 728), Kings Bay, GA
USS Georgia (SSGN 729), Kings Bay, GA

Last Update: 6 December 2013

APPENDIX B. OUTPUTS OF THE EXECUTIVE TANG FORUM

1. Submarine Operations Navigation Integrated Console–Wardroom Horizontal Integrated Planner (S.O.N.I.C.–W.H.I.P.)–Horizontal touch-enabled planning board using layered information on a geographic plot to enable better command-team planning. Solutions can be shared quickly from the main board to tablet devices for mobility around the submarine.
2. Battlespace Operational Management Board (B.O.M.B.)–Permits real-time sketching by watch team members on their tactical displays, which then populate to the displays of the other team members and the CO. Portable tablet version as well. Permits quick annotation and complex communication between watch-standers to promote collaboration.
3. SUBIPEDIA–Wiki-style lessons learned and information sharing system, fusing various information sources (classified and unclassified) into a single source. Offers "Yelp-style" helpfulness ratings and offers a way for users to provide additional, crowd-sourced input.
4. Risk Assessment–Creates a visualization depicting factors of risk versus benefit to support collaborative decision making. Further provides mitigation options for consideration. Envisioned as a tool to promote holistic discussion between leadership, not a "decision-making machine."
5. Commanding Officer Safety and Tactical Automated Reporting System (C.O.S.T.A.R.)–Allows face-to-face communication between the watch team and the CO, regardless of the CO's location aboard the submarine, using tablet communications technology, such as Face Time.
6. Automated Solution Development (A.S.D.)–Automatically develops targeting solutions and sonar contacts while permitting editing and further evaluation by the sonar watch team, as necessary.
7. Attack in a Minute (A.I.M.)–Creates an attack plan based on sensor data, tactics, targets, and employment options. Dynamically updates target data while eliminating the pre-launch and post-launch display requirements.
8. Central Automated Navy Objective Lessons-learned Inventory (CANOLI)–Geographically enabled lessons-learned library that offers commanding officers access to relevant lessons-learned for a particular geographic area. The data is sourced from the full submarine fleet and shared among all crews.
9. Decision Support–Fused data system offering suggested courses of action to commanding officers for further consideration and comparison. Courses of action are developed using historical data, current intelligence, target plot, and threat conditions.
10. Lessons-Learned Creation Suite–A quad plot combines rich media into a single file consisting of a narration video, fusion plot, common broadband, and all relevant data files. Allows a CO to record and play back an incident, positive or negative, and

narrate it. The contents are easily formatted into an audio or video report using a simple template to enable sharing of lessons learned between submarines and crewmembers.[319]

[319] IDEO, *Executive TANG Forum*.

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